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THE TREATMENT

OF

PLEURISY AND EMPYEMA

BY

BYROM BRAMWELL, M.D., F.R.C.P.Ed.,

LECTURER ON THE PRINCIPLES AND PRACTICE OF MEDICINE IN THE EXTRA-ACADEMICAL SCHOOL OF MEDICINE, EDINBURGH; ASSISTANT PHYSICIAN TO THE EDINBURGH ROYAL INFIRMARY.

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THE TREATMENT OF PLEURISY AND EMPYEMA.

PART I.

TREATMENT OF PLEURISY.

THE causation, character, and intensity of the inflammations included under the common term pleurisy, vary so greatly in different cases, that in order to intelligently treat any individual case of the disease, the physician must endeavour to determine the exact mode of causation, the variety and the intensity of the inflammation in each particular case, together with the special peculiarities of each individual patient (his general constitutional state, his hereditary tendencies), and any associated pathological conditions which may happen to be present.

CLASSIFICATION AND ETIOLOGY.

Pleurisies may be classed in various ways, viz.—into (1.) acute, subacute, and chronic; (2.) dry and moist; (3.) localised and general; (4.) primary and secondary; and (5.) simple and (apparently) idiopathic on the one hand, and, on the other, the pleurisies associated with some distinct and definite cause, as—

(a.) *Primary lung disease*—phthisis, catarrhal pneumonia, acute croupous pneumonia, pulmonary apoplexy, deposits of new growths.

(b.) *The extension of an inflammation from some adjacent organ or part,* such as the pericardium, liver, peritoneum, &c. (extensions from the inflamed lung are included under heading (a)).

(c.) *Septic conditions* and general diseases, such as puerperal fever, pyæmia, erysipelas, scarlet fever, typhoid, &c., in which inflammations, which are usually purulent, are apt to arise.

(d.) *General constitutional conditions and diseases,* such as the various forms of Bright's disease, in which we know by experience that pleurisy (generally sero-fibrinous) frequently occurs.

Rheumatism, gout, and other constitutional affections which debilitate the system, must also be looked upon as predisposing, and in some cases as exciting causes of pleurisy. In such conditions as purpura and scurvy, the effusion may be bloody.

(e.) *Tubercular and cancerous* deposits in the pleura itself.

(f.) *Traumatic* injuries to the chest wall; in almost all cases the ribs are fractured, but I have seen at least one case in which no fracture could be detected by the most careful examination.

Practical Classification.—A good practical classification, which I have found useful for clinical purposes, is the following:—

1. Dry pleurisies (acute, subacute, and chronic).
2. Acute pleurisies with sero-fibrinous exudation.
3. Acute pleurisies with purulent exudation.
4. Chronic pleurisies with sero-fibrinous exudation.
5. Chronic pleurisies with purulent exudation.
6. Pleurisies with effusion (sero-fibrinous or purulent) associated with pneumo-thorax, phthisis, or other chronic lung diseases.
7. Double pleurisies.
8. Hæmorrhagic pleurisies.

DRY PLEURISIES.

Dry pleurisies are usually localised, generally secondary, and associated with (due to) primary lung disease, such as pneumonia or phthisis. Occasionally (and in my experience much more frequently than some writers seem to suppose) dry pleurisies occur without any obvious local pulmonary cause, apparently idiopathically or from exposure to cold in (?) healthy persons, or in those affected with Bright's disease or other debilitating condition.

Dry pleurisies may be attended with a good deal of pain, but are seldom of any great practical importance. They usually result in the production of localised thickenings or adhesions, which in the case of phthisis may be conservative and protective against pneumo-thorax.

The frequency with which localised pleuritic adhesions are found post mortem proves that dry pleurisy is a very common affection.

In the great majority of cases, the treatment essentially consists in the relief of the catching pain in the side, which is the most common and prominent symptom of the condition. The application of a blister over the seat of the pain, and the administration of a sixth or a quarter of a grain of morphia hypodermically, are the means which I usually employ. In those cases in which firmly supporting the side with the hand is found to relieve the pain, strapping the chest may be all that is required.

The internal treatment must be largely regulated by the condition with which the pleurisy is associated. In idiopathic or rheumatic cases, a brisk purge, and the internal administration of a few grains of Dover's powder or of quinine, or some anti-rheumatic remedy, such as salicin, are beneficial.

In dry pleurisy, the pyrexia (if any) is usually so trifling that no special anti-pyretic remedies are required.

ACUTE PLEURISY WITH SERO-FIBRINOUS EFFUSION.

In this variety, as the title indicates, the onset is acute, is often accompanied by a feeling of chilliness, but, unless in exceptionally severe cases, there is not usually a distinct and definite rigor, such as occurs at the commencement of an attack of acute croupous pneumonia.

A stabbing pain in the side, which catches the breath, is the most characteristic symptom in the early stage of the disease.

It is important to remember that in some cases, more especially in children, the pain is not referred to the affected part of the chest, but to the abdomen, or even, it is said, to the opposite side of the thorax. With the occurrence of effusion, the pain diminishes or altogether disappears.

There is usually more or less cough, but little or no expectoration, unless bronchial catarrh or some other complication, such as pneumonia, is also present.

In the great majority of cases the pyrexia is moderate in degree, the temperature not usually exceeding 101°, 102°, or at most 103° F. In severe cases of simple (sero-fibrinous) pleurisy, it may reach 104° or 105°, and in exceptional (*foudroyant*) cases it may be even higher. Great febrile disturbance is suggestive of a septic origin, or of the presence of some complication.

The rate and character of the respiration depend largely upon the amount of the effusion and the rapidity with which it is poured out. In the earlier stages, the respirations are shallow and quick, but there is no true dyspnœa; when the effusion is copious and rapidly poured out, more urgent dyspnœa (or orthopnœa) may be present. In many cases in which the effusion is copious, but in which it is slowly and gradually produced, there is no marked dyspnœa except on exertion, coughing, &c.

In the earlier stages, the patient usually lies on his back or on the sound side, for pressure on the diseased side increases the pain; when the effusion is copious, the patient instinctively turns on to the diseased side in order to remove the pressure from the mediastinum and give the sound lung free play. A change of decubitus, from the back or sound side to the diseased side, is therefore highly suggestive of the occurrence of copious effusion.

Should the patient come under observation in the early stages of the case, the to-and-fro friction sound (pleuritic rub) can usually be heard over the affected part of the chest. In many cases, the friction has already disappeared (or at all events has in places disappeared) when the patient comes under observation, and the physical signs indicative of effusion, viz.—(1.) dulness on percussion, with the characteristic S-shaped curve described by Ellis, Garland, and Powell; (2.) Skodaic resonance above the level of the fluid; (3.) diminished breath sounds, vocal resonance, and vocal fremitus; and (4.) some displacement of the heart, are present.

It is important to remember that in some cases of pleurisy with effusion, the breath sounds (bronchial or almost tubercular breathing) and the heart sounds are so loudly heard over the affected side, as to suggest the presence of pneumonia rather than of pleuritic effusion. Cases of this description are in my experience most frequent in children, but I have seen many cases in the adult. In several, the bronchial breathing was so distinct as to make the medical attendant have grave doubts as to the advisability of puncturing the chest, though (granting that the dulness was due to pleuritic effusion and not to pneumonia) the operation was clearly indicated by the great extent of the dulness and the other conditions of the case.

Hilton Fagge directs attention to the fact that it is in the later stages, and when the effusion is copious, and the affected lung "completely flattened and airless, that the inspiratory sound from the opposite lung is very apt to be carried across the spine in such a way as to suggest that air enters both sides of the chest. Why," he says, "this should be the case when the disease is advanced, and not at its commencement, I do not altogether understand. Perhaps it is because the respiratory movements are at first so shallow." [1]

Complete compression of the lung, rendering it a better conductor of sound, and the presence of adhesions, which may themselves act as sound conductors, and which bind the lung to the chest wall and prevent its collapsing before the fluid, doubtless account for the presence of the breath sounds in certain cases.

In cases of pleurisy of this kind, which simulate pneumonia, and in the reverse cases, which are still more difficult of diagnosis, but fortunately very rare, in which no breath sounds are heard over a consolidated pneumonic lung, owing to the fact that the bronchi leading to the affected part are plugged with thick heavy secretion, a diagnostic puncture may be the only absolutely certain means of diagnosis; and since, if performed with due antiseptic precautions, this procedure is absolutely safe and attended with little or no suffering to the patient, it should in all doubtful cases be put into practice.

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[1] *Principles and Practice of Medicine*, 1886, vol. i., page 992.

In most cases, the more absolute character of the dulness (or flatness, as the Americans term it), and its characteristic S-shaped outline (see page 26), enable us to decide the point and to render the diagnostic puncture superfluous. But it must be remembered that the dulness due to pleuritic effusions does not in all cases present the S-shaped outline, and that the degree of dulness (flatness) cannot always be absolutely relied upon.

In connection with the difficulty that there sometimes is in distinguishing cases of acute pleurisy with effusion and acute croupous pneumonia, I may refer to the fact that when a lung which is partly adherent to the chest wall or diaphragm (as the result of old pleurisy) is affected with acute croupous pneumonia, the pain—which is due, I suppose, to the swelling of the lung and the stretching of the adhesions—may be intense. In one case of this kind (septic pneumonia), which came under my observation about two years ago, and in which the bronchi were plugged with thick heavy masses of purulent and blood-stained sputa, the physical signs were absolutely characteristic of pleuritic effusion, but repeated aspiration with needles of various sizes failed to extract any fluid from the chest.

The differential diagnosis of pleuritic effusion and solid intra-thoracic tumour is sometimes a matter of great difficulty. It chiefly occurs in chronic cases, and is afterwards referred to.

The difficulty that there is in determining the exact physical conditions (the presence or absence of fluid) when the thorax is mis-shaped and the solid abdominal organs (liver and spleen) are situated high up under cover of the ribs, need not be specially considered.

The intensity of the febrile process, the amount of the effusion, the rapidity with which it is poured out and with which it is absorbed; in other words, the severity and duration of the different stages of the disease—(1.) the period of fever and development of the effusion; (2.) the stationary period, during which the effusion remains at its height; (3.) the period of absorption and resolution—are very variable in different cases.

So far as treatment is concerned, it is of the utmost importance to remember—

Firstly, that acute primary (simple) pleurisy with sero-fibrinous effusion is essentially a unilateral affection, and that in those cases in which the condition is bilateral, the presence of a septic cause—of tubercle, or cancer, or some other general diathetic condition—should be suspected.

Secondly, that although the severity and duration of the disease vary very greatly in different cases, and there is no critical period of termination, such as occurs in acute croupous pneumonia, for example, the natural termination is absorption of the fluid, and a cure, usually with the formation of adhesions, which more or less extensively bind the affected lung to the side of the chest; that, in short, the great majority of cases of acute pleurisy with sero-fibrinous effusion will, if left to themselves, end in a natural cure.

But a complete cure does not invariably take place. Contrary to the statement of Laennec, some cases die from the mere severity of the attack (intensity of the inflammatory process, and rapidity and copiousness of the effusion) during the first febrile period. Such (*foudroyant*) cases, though very rare, do undoubtedly occur, and two have come under my own observation within the past few years. In other cases in which the effusion is large, sudden death occurs after the acute (febrile) symptoms have subsided, and is apparently due to over-exertion, syncope, or embolism.

In others, again, in which the fluid is very slowly absorbed, the lung which has been subjected to long-continued pressure, and which is fixed down by firm adhesions, does not expand, but remains more or less collapsed and permanently disabled.

In consequence of these risks and dangers, it is impossible to be content with a merely expectant plan of treatment (though doubtless in the majority a natural cure would in that way ultimately take place): but we must be prepared, whenever it may seem necessary, to actively assist nature to shorten and limit the inflammatory process, to relieve the intra-thoracic pressure, to produce absorption of the effused fluid, and so endeavour to prevent a fatal issue and the occurrence of any permanent injurious results.

Indications for Treatment.—The indications for treatment are as follows:—

1. To cut short and allay the inflammatory process, and diminish, so far as possible, the amount of the inflammatory exudation.

2. To relieve any urgent symptoms which may arise,—such, for example, as severe pain or dyspnœa.

3. Whenever the effusion is so quickly poured out or so copious as to seriously embarrass the breathing, or whenever the effusion, whatever its amount, threatens to endanger life, to perform the operation of paracentesis, whether the case is in the early (febrile) stage or not.

4. As soon as the febrile process has subsided, to endeavour to aid nature, both by local and general means, to effect the absorption of the inflammatory products.

5. If the natural process of absorption does not commence within a reasonable time after the febrile process has subsided, to assist nature by drawing off a portion of the fluid.

6. Whenever the effusion is purulent, to evacuate the pus as speedily and as completely as possible. This indication, which does not of course apply to the simple (sero-fibrinous) pleurisies with which we are at present concerned, is afterwards

considered in detail. I have expressly incorporated it here with the double object of emphasising its importance and of directing attention to the fact that, in children more especially, some acute pleurisies, which may appear to be simple (sero-fibrinous), are in reality purulent.

The chief means by which these several indications are to be carried out must now be described.

The treatment of the first or febrile period of the attack.—In cases of average severity the febrile process extends over several days. Usually at the end of a week or ten days the fever subsides, the temperature becomes normal, the tongue cleans, the appetite returns, and the inflammatory exudation begins to be absorbed.

The duration of the febrile period may be very short—a few hours or a day or two—but in ordinary simple sero-fibrinous pleurisy it is rarely prolonged beyond ten days or a fortnight. In those cases, therefore, in which the pyrexia persists beyond this period, the presence of some complication, or the likelihood of the exudation being purulent, should be suspected. With the object of definitely deciding whether the exudation is sero-fibrinous or purulent, the diagnostic puncture should consequently be employed in all cases of pleurisy with effusion in which the febrile process persists beyond the usual period.

During the febrile period, and indeed so long as any considerable amount of fluid remains in the cavity of the pleura, the patient should be confined to bed.

The temperature of the room in which he is placed should be maintained at a uniform point (about 60° F.). His position should be that which he instinctively finds is the most comfortable and easy.

The diet should be such as is suited for a fever patient (milk, beef-tea, soups, beaten-up eggs, &c.); solid food being avoided during the acute stage of the condition.

In cases of pleurisy with effusion, only as much fluid (water, barley water, lemon water, &c.) as is necessary to quench the thirst, which in some cases is troublesome, should be allowed, but the patient should be forbidden to drink copiously. As a thirst quencher citric acid is often useful.

When the case is seen quite at its commencement, general blood-letting, cupping, or leeching the affected side, the local application of cold, in the form of an ice-bag, brisk purgation, and the internal administration of a large dose of quinine (10 to 15 grains), followed by smaller quantities (3 or 4 grains every four or six hours), of tartar emetic, of calomel and opium, are some of the means which have been recommended with the object of cutting short and allaying the attack.

For my own part, I have been in the habit of applying leeches or hot poultices, or if there is much pain, a blister, locally; and of administering a brisk watery purge (sulphate of magnesia or the compound jalap powder) with quinine internally.

In most cases the febrile process is fully established, and more or less inflammatory exudation already present, when the case comes under observation.

In the average run of cases in which the fever is not great, quinine (2 or 3 grains every four or six hours), or the liquor ammoniæ acetatis (1 or 2 drachms every two or three hours), may be given.

When the fever runs high (102° or 104° F.), and the pulse is hard and tense, small and frequently repeated doses of tartar emetic (fifteen drops of antimonial wine every four hours) may, I believe, in many cases be given with advantage. Aconite (drop doses of the tincture every hour) is strongly recommended by some authorities under the same circumstances, but, personally, I prefer small doses of tartar emetic; while quinine (in large doses), antifebrin, antipyrin, or phenacetin may be prescribed, should it appear necessary to bring down the temperature rapidly. It is rare that such remedies as antifebrin and antipyrin are indicated, and in those (foudroyant and septic cases) in which the temperature is very high (105°, 106° F., or more), I very much doubt whether their administration is likely to be attended with much benefit. In such conditions I should prefer to give quinine internally, and when it is necessary to reduce the temperature rapidly, to do so by the local application of cold (sponging, ice pack, &c.) to the surface of the body.

The administration of jaborandi, or its active principle pilocarpine, a remedy which has been highly recommended during the absorption (post-febrile) period, may also be given with advantage during the earlier periods of the case.

The question of paracentesis during the early (febrile) period of the disease is one which has given rise to considerable difference of opinion. In common with the great majority of physicians in this country at all events, I have been in the habit of teaching that the operation should not be performed during the febrile period, unless the effusion accumulates so rapidly as to seriously embarrass the respiration or to endanger life; unless, in short, there is some obvious and pressing reason for interference.

Some writers differ from this opinion. Castiaux (quoted by Donaldson) strongly advocates the view that the operation by aspiration will hasten the cure of acute pleurisy, and prevent the formation of fibrinous deposits and bands, which to a greater or less degree, even in moderate effusions, impair the expansion of the lungs. He relates thirty-seven cases, almost all of which were operated upon by himself. He was successful in all of them, and the patients suffered no inconvenience or discomfort in consequence. In most of his cases the pulse and body temperature fell (perhaps the same day, certainly the next morning), and even became normal after the operation, and the patients improved rapidly. He aspirated as soon as he detected the fluid by exploratory punctures, believing that from the moment we have at our disposition sure means of relief which are harmless, it is useless to leave to nature the duty of removal —useless to leave to untrustworthy medication the relief which we can promptly give. He operated at the height of the first or inflammatory stage of the disease. He assigned as reasons for operating that he thereby relieved the lung of the compression which impairs expansion; that he removed a liquid rich in fibrin, and capable of increasing the thickness of the neo-membranes; that by restoring the power to dilate, he further prevented the lung from being compressed by the false membranes. These membranes cannot become organised unless they are separated by fluid. He states that he removed the fluid as completely as possible. As soon as the cavity was emptied, respiration was made easy and the patient was relieved. Auscultation showed, by the vesicular murmur, that the lung had resumed its place without difficulty from top to bottom. The effusion returned only in a few cases, with high temperature and frequent pulse, but another operation effectually arrested them. The pleurisy was cut short, and puncture was considered the means of abating the disease. The duration of the disease treated by this means was much shorter. Thus the patients were not forced to retain for months the liquid and false membranes in their chests. He states emphatically that there never supervened any accident, and especially that he never witnessed as a result the transformation of the serosity into pus, although it might appear likely to occur, as the serous membrane, already inflamed, ought to be more sensitive to injury.[1]

Moutard-Martin, Wedal, and Mason (also quoted by Donaldson), report favourable results from the same plan of treatment.

In considering this question, it must be remembered that during the febrile period the effusion is accumulating, and that it is only after the febrile process has subsided that the process of absorption of the exudation products can commence. My rule in practice, which is based on this pathology, has been to wait until the febrile process has subsided, and to allow a reasonable time for the natural absorption process to do its work. I have been in the habit of recommending the operation of paracentesis whenever, during the febrile stage, a pleuritic effusion seemed to be the cause of serious symptoms (such as orthopnœa), or to endanger life; or when, during the post-febrile period, the natural process of absorption seemed unequal to effect its removal.

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[1] Pepper's *System of Medicine*, vol. iii., page 527. See also *Thèse de Paris*, 1873 (Castiaux); *Étude clin. des épanchments Pleurit*, 1877 (Wedal); and *Boston City Hospital Reports*, 3d Series, 1882 (Mason).

In two very severe (*foudroyant*) cases, in which, in addition to high fever, very quick pulse, and great prostration, a very large amount of sero-fibrinous fluid was rapidly poured out, I was obliged to tap during the febrile period to relieve the urgency of the condition; no distinctly beneficial effect resulted, both patients dying notwithstanding the operative interference. In two other cases, seen several years ago, in which the symptoms were much less urgent, and the cases much less severe, I had recourse to paracentesis during the febrile period, in consequence of the large quantity of effusion which was present. Both of these cases did well. Of late years, I have adhered to the rule laid down above, and have refrained from tapping during the febrile period, unless in the very severe (*foudroyant*) cases in which the fluid accumulates in such quantity or with such rapidity as to produce urgent symptoms, and in which there are any indications that it endangers life.[1]

In the earlier stages of acute pleurisy with effusion, pain is the symptom which chiefly demands relief. The hypodermic injection of morphia, leeching the affected side, or the application of a blister or hot poultice, are the means which I have usually employed for its relief.

In those cases in which cough is unusually troublesome, I have found morphia or some preparation of opium the most efficacious remedy. When bronchial and pulmonary complications are present, other measures may be required.

Urgent dyspnœa, or paroxysmal attacks of orthopnœa, when associated with, and apparently due to pleuritic effusion, are symptoms of great significance, and are best treated by paracentesis; but this point will be presently considered in more detail.

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[1] See also on this point *Contributions to Clinical and Practical Medicine* by Dr. Waters, page 131 *et seq.*

The embarrassment of the action of the heart and of the circulation, which is associated with a copious effusion, is often very markedly relieved by withdrawing a portion of the fluid by means of paracentesis, the pulse becoming slower, fuller, and stronger as the fluid is withdrawn.

Great general prostration or cardiac failure (manifested by great frequency, feebleness, and irregularity of the pulse), such as occur in very severe (*foudroyant*) cases of simple (sero-fibrinous) pleurisy and in some septic conditions, and which do not appear to be directly due to the presence of a large effusion—should be treated by the administration of stimulants and cardiac tonics (brandy, ether, digitalis, &c.).

The treatment of the second or post-febrile period of the disease.—The main indication during the post-febrile period is, as we have already seen, to aid nature in the absorption of the inflammatory exudation.

In most cases the effusion, which usually begins to be poured out during the earlier period (first day or two) of the inflammatory or febrile stage, continues for several days slowly and gradually to increase.

At the end of ten or fourteen days the effusion has generally reached its height. After a stationary, or apparently stationary period, which is usually of brief duration, varying from a few hours to two or three days, the natural process of absorption begins to take place.

When the effusion is in large amount, the duration of the absorption period is generally considerable; it is usually several weeks, and it may be even longer, before the dulness completely clears up. Some dulness at the base frequently remains for a considerable time, but, in some cases at all events, it is due not so much to fluid which has not been absorbed, as to the presence of thick flocculi of solid or semi-solid exudation material, or to thickening of the pleura itself.

The exceptions to this, the normal course (rise and fall) of the effusion, are very numerous.

In rare cases, as we have already seen, the effusion is poured out so rapidly and in such large quantities as to cause very serious embarrassment of the respiration during the first or febrile stage of the disease, and even to threaten life itself.

In mild cases, on the other hand, in which the febrile process is of brief duration and the amount of the effusion small, the maximum point of the effusion is very quickly reached.

In some cases the effusion continues to increase after the end of the second week, and it may be twenty-one days, or even longer, until the maximum is attained.

In other cases the stationary period is unusually prolonged, or natural absorption fails altogether to take place. In persons who are naturally delicate; in those who are debilitated by previous illness, more especially when the disease has been one (such as typhoid) which produces a profound disturbance of nutrition; in those who are suffering from serious organic disease, such as Bright's disease,—the stationary period is apt to be prolonged, and the periods of absorption and convalescence slow and tedious. In old people, and in those whose hearts are feeble or diseased, absorption is often delayed or does not take place.

Further, it must be remembered that some of these cases in which the natural process of absorption does not take place, the effusion is purulent, or the pleurisy is tubercular.

The positive pressure, which a copious effusion exerts upon the blood-vessels and lymphatics of the wall of the pleural sac, frequently interferes with the natural process of absorption, more especially in delicate and debilitated subjects, and in persons whose hearts are temporarily weakened or diseased.

Moreover, it is important to note that the natural process of absorption is sometimes attended with a copious diuresis; and, *vice versâ,* that arrested absorption is sometimes accompanied by, and apparently dependent upon, diminished urinary secretion and congestion of the kidney. And further, that the copious watery discharge from the bowel, which attends an attack of Asiatic cholera, has been known to be accompanied by the rapid removal (absorption) of a pleuritic effusion.

With these facts in view, it is obvious that, with the object of assisting nature to effect absorption of the inflammatory exudation, we must—

(1.) Endeavour to restore the general health and nerve tone by suitable hygienic and dietetic measures, and by the administration of general tonic remedies.

(2.) Stimulate and strengthen the action of the heart by the administration of cardiac stimulants and tonics, when such remedies seem called for.

(3.) Promote the free action of the bowel, kidneys, and skin.

(4.) Administer such internal remedies and make use of such external measures as experience has shown are useful for promoting the absorption of inflammatory products.

(5.) Remove a portion of the effused fluid in those cases in which the positive pressure exerted by the fluid seems to interfere with the natural process of absorption.

Further, it is essential to remember (6.) that in all cases in which the effusion is apparently the cause of alarming symptoms, or in which it is so copious as to endanger life, or by its continuance to be likely to produce permanent damage to the lung, the operation of paracentesis should be at once performed.

It must be remembered that in the great majority of cases of average (ordinary) severity, nature is quite equal to the emergency, and no very active assistance, such as paracentesis at all events, is required.

In such cases, as soon as the fever subsides, the patient should be encouraged in the idea that the inflammation is now at an end, and that the period of convalescence is about to commence. I attach great importance to the administration of such mental tonics, and think it of the utmost importance that the patient's surroundings should be as pleasant and cheerful as possible. During the second period of the disease the ventilation of the room in which the patient lies should continue to be scrupulously attended to.

As soon as the tongue clears, the patient may be gradually placed on a more liberal diet (fish, chicken, red meat being gradually introduced in accordance with the individual conditions of each case).

The question of stimulants depends partly upon the condition of the heart and pulse, partly upon the previous habits of the patient as regards alcohol. Patients who have been accustomed to take stimulants regularly should be allowed to take their usual quantity of alcohol, and perhaps a little more, as soon as the febrile process has subsided. Persons who are unaccustomed to the use of alcohol often do quite well without it, but I am disposed to think that even in such persons absorption usually proceeds more satisfactorily, and convalescence is more quickly reached, when a certain amount of alcoholic stimulant is added to the dietary.

The exact form of the stimulant (beer, burgundy, champagne, port wine, or spirits) must of course be determined by the condition of the stomach, previous alcoholic habits, and special requirements of each case.

In those cases in which there is marked cardiac weakness much larger quantities of alcohol may of course be required than in the ordinary run of cases. In severe, and more especially septic cases, it may be necessary to commence the administration of alcoholic stimulants during the early periods of the febrile stage; but in cases of average (moderate) severity, in which the pulse keeps good, and there are no special indications of cardiac failure, alcohol is not as a rule required until the second or post-febrile stage of the disease is reached.

Care must be taken that the bowels act regularly and freely. An occasional watery purge—a few grains of calomel, followed in the morning with sulphate of magnesia or a dose of Friedrichshall or other purgative mineral water—may in most cases be given, every now and again, with advantage.

Provided that the kidneys are functionating actively, diuretics are not required. If the quantity of urine is not sufficiently copious, some of the salts of potash (the citrate, acetate), with digitalis or decoction of scoparium, often prove very advantageous. If there is any complication on the part of the kidney—such, for example, as acute or chronic Bright's disease—the diet and treatment must, of course, be modified in accordance with the special requirements of the case.

In addition to the regulation of the diet, stimulants, general surroundings of the patient, and encouraging the free action of the bowels and kidney,—iron, quinine, the mineral acids, strychnine, or other tonic may be prescribed. The tincture of the perchloride and the syrup of the iodide of iron are most useful remedies at this period of the case. When the tongue continues furred, I have seen great benefit from the administration of dilute nitric acid, strychnine, and gentian.

Locally, I am in the habit of applying a blister and painting the chest with tincture of iodine until the skin becomes sore. Some writers strongly recommend strapping the chest. In some few cases in which I have methodically employed this method of treatment it has seemed to be beneficial; but in other cases, by interfering with the free play of the thorax, it has appeared to me to be the reverse of helpful.

I attach considerable importance to the so-called lung gymnastics, and encourage the patient during the absorption period to make from time to time powerful expiratory efforts with the mouth and nostrils closed. I believe that in this way collapsed portions of lung tend to become expanded, the absorption of fluid by the vessels and lymphatics in the pleural wall is facilitated.

In those cases in which absorption does not take place, or in which the process proceeds in a sluggish manner, the first object of the physician should be to endeavour to determine the cause of the non-absorption.

In those cases in which it appears to depend upon general debility, the quantity of alcoholic stimulant may be increased, the diet made still more liberal (always provided that the digestion is equal to the change), and the tonic which the patient has been taking increased in strength or altered.

If there is any special cardiac debility or disease, digitalis is often most valuable.

Iodide of potassium is a remedy which is largely given during the second period of the disease, and in some cases it seems to exert a distinctly beneficial effect in promoting the absorption of the effusion.

Hilton Fagge speaks strongly of the benefits derived from the local application of mercurial ointment. "I am convinced," he says, "that I have several times seen marked results from the application of mercurial ointment, a rub which has been heard day after day for weeks ceasing almost as soon as it was used, or fluid effusion clearing away after a somewhat longer period."[1] The advantages of mercury have also been strongly insisted upon by Dr. John Macdougall. He recommends, in opposition to the teaching of Thorowgood, that the drug should be continued in minute doses after the pulse and temperature have returned to the normal, *until in fact* the effusion has disappeared.[2]

Free watery purgation at occasional intervals is, in some cases, distinctly beneficial. In those cases in which the action of the kidney is defective (and in which there is no acute organic disease) diuretic remedies should be administered. The administration of jaborandi, or its active principle pilocarpine, may also be tried when absorption is sluggish or in abeyance. Dr. J. W. Hunt (quoted by Donaldson in Pepper's *System of Medicine,* vol. iii., page 520) has obtained most marked and successful results from this remedy, even when other means have failed. He pushes it so as to produce free diaphoresis. "In none of the cases," he states, "was there any beneficial result obtained till profuse diaphoresis was created."[1] The great depression which attends the profuse diaphoresis produced by this drug must be controlled by the administration of stimulants and by the subsequent exhibition of iron and a liberal dietary.

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[1] *Principles and Practice of Medicine*, 1886, vol. i., page 924.

[2] *Practitioner*, vol. i., 1884, page 427.

When the amount of effusion is large and absorption does not take place, or proceeds in a very sluggish manner, the operation of paracentesis should be had recourse to, and a small portion of the fluid withdrawn, so as to reduce the intra-thoracic pressure and relieve the vessels and lymphatics in the wall of the pleural sac.

And here, perhaps, it may be well to consider in some detail the indications for paracentesis, and the manner in which the operation is to be carried out.

The operation of paracentesis is performed in cases of simple (sero-fibrinous) pleurisy with three main objects, viz.:—

(1.) To remove conditions dangerous to life;

(2.) To relieve urgent symptoms;

(3.) To initiate or facilitate the natural process of absorption, and to prevent long-continued compression of the lung, and the permanent injurious alterations which may result therefrom.

Paracentesis should therefore be performed under the following circumstances:—

(1.) Whenever the effusion is so copious as to be attended with risk to life, or to produce injurious compression of the lung.

(2.) Whenever urgent or dangerous symptoms, apparently the result of the pleuritic effusion, whether that effusion is copious or not, are present.

(3.) When, a reasonable time for natural absorption of the pleuritic effusion having been allowed, absorption does not take place.

Two questions at once arise, viz.—*What amount of pleuritic*

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[1] *Dublin Medical Journal,* Dec. 1879, page 365.

effusion is to be considered as dangerous, and what amount of effusion is likely to produce injurious compression of the lung?

In order to give an intelligent answer to these questions, it is necessary to consider the effects which a gradually increasing pleuritic effusion produces on the lung, and the manner in which pleuritic effusions may prove dangerous or injurious.

Garland, as the result of an important series of experiments and observations, believes that an effusion which is poured out into the pleura first collects in the posterior and inferior part of the thorax, between the lung and the diaphragm; that as the fluid accumulates the lung contracts as a whole and recedes before the fluid, the elasticity of the lung holding up, as it were, the fluid, the pressure in the pleural cavity continuing to be negative and preventing the upper level of the fluid being a horizontal level, as it would be if it were acted upon by the law of gravity alone. Further—and this is the important point so far as our present purpose is concerned—that it is not until the fluid has become considerable in amount that the (normal) negative intra-pleural pressure is converted into a positive pressure, the elasticity of the lung overcome, and the lung tissue subjected to active and injurious compression.

Garland's views as to the manner in which pleuritic effusions affect the lung are not accepted by all authorities. Thus Hilton Fagge states—"When pleural effusion is insufficient in quantity to cause the lung, as a whole, to become empty of air, and when, therefore, *compression* of the organ is a long way from having begun, the effect on the pulmonary tissue is very different from what is generally supposed. I think," he says, "that every one would anticipate that the elasticity of the organ would lead to a gradual and uniform shrinking of its substance, so that all parts of it should contain less air than before, without any part becoming completely airless. But the exact contrary is in fact the case. Dr. Moxon long ago pointed out to me, when he was demonstrator of pathology at Guy's Hospital, that the presence of even a few ounces of liquid in any part of the pleural cavity causes a total collapse of the pulmonary tissue which ought to occupy that space. I have since repeatedly verified his observations; and Cohnheim, at page 190 of vol. ii. of his 'Vorslesungen,' makes a precisely similar statement. One often sees a small triangular area of collapsed lung substance at the posterior inferior corner of the organ, or a thin strip of it moving up along its posterior margin. Nay, a mere enlargement of the heart, without there being any pleural effusion, may give rise to complete airlessness of the inner surface of the left lung; and distention of the abdomen, thrusting up the diaphragm, may cause a similar affection of the inferior surface either on one side or on both. The explanation of these remarkable facts can hardly be understood except in connection with the mode of origin of collapse of the pulmonary tissue, which has been described in the chapter on bronchitis. It depends upon the general principle, that whenever a part of the lung fails to be acted upon by the inspiratory forces, it becomes airless, notwithstanding that the tubes which serve it remain patent."[1]

Garland and Powell believe (and whether Garland or Hilton Fagge is right as to the effect which small pleuritic effusions exert upon limited portions of the lung, we may, I think, for practical purposes accept the conclusion as correct) that so long as the intra-pleural pressure remains negative the lung does not seriously suffer; in short, that it is only when the effusion becomes sufficiently copious to produce positive pressure within the pleural sac, that the lung is subjected to injurious compression, the heart pushed to the opposite side, the diaphragm depressed, and the liver, stomach, and spleen displaced downwards.[2]

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[1] *Principles and Practice of Medicine*, 1886, vol. i., page 916.

[2] Douglas Powell has shown that even with small or moderate pleuritic effusions the heart is displaced towards the opposite side; but this displacement is not due to pressure exerted by the fluid, for it occurs when the intra-pleural pressure, as measured by the manometer, is still negative, but to the elasticity and negative pressure exerted by the sound lung (*i.e.*, the lung on the opposite side to the effused fluid).

Further, all observers are agreed that an amount of effusion sufficient to produce positive pressure within the cavity of the pleura must be regarded (quite irrespective of the permanent injurious results which, if long continued, it may produce in the lung which it compresses) as a dangerous amount.

The danger is of course greater when the effusion is rapidly poured out; and, as has been previously pointed out, urgent symptoms (such as cough, dyspnœa, orthopnœa, a small, weak, or irregular pulse, cyanosis, faintness, &c.) are usually present under such circumstances. Nor is this to be wondered at when it is remembered that, under such circumstances, almost the whole aerating function is *suddenly* thrown upon the sound (opposite) lung, and that in consequence of the compression to which the lung on the diseased side is subjected, the vessels of the sound lung have to accommodate much more than the normal amount of blood, engorgement of the organ is in fact produced, and an impediment offered to the blood in its passage from the right to the left heart.

There is, in consequence, a tendency to this production of congestion and œdema in the sound lung—a very serious complication; the right heart becomes engorged, the left heart receives a diminished supply of blood; and there is a tendency to the production of arterial anæmia and venous plethora in the peripheral circulations.

The difficulties of the circulation are probably still further increased by the dislocation of the heart (which, in the case of large left-sided pleuritic effusions, may be considerable), and by the interference with the free flow of blood through the inferior cava, which is apt under such cases to be twisted and constricted as it passes to the heart through the quadrilateral foramen in the diaphragm.

When, therefore, positive intra-pleural pressure is quickly established by the rapid production of a very large pleuritic effusion, the patient is in imminent danger from the possible occurrence of œdema or other complications in the sound lung, and from failure or interference with the action of the heart.

The latter risk is of course intensified when the heart itself is debilitated and diseased; hence the very great importance of regarding the condition of the heart in cases of pleuritic effusion, both for the purposes of prognosis and treatment.

But it is not only when the effusion is rapidly poured out that danger is to be apprehended. Large pleuritic effusions which are slowly established, or which are stationary and chronic, are by no means altogether devoid of danger. In such cases there are usually no symptoms, certainly no urgent symptoms, so long as the patient is at rest; but exertion induces cough, dyspnœa, and a tendency to cyanosis, cardiac failure, or syncope; and we know, as a matter of fact, that patients with large pleuritic effusions occasionally do die suddenly if they are allowed to go about and exert themselves. In such cases, too, there is always the risk of the occurrence of complications (bronchitis, œdema, congestion, &c.) in the sound lung—conditions which at once produce urgent symptoms and place the patient in great danger.

And here it may be well to state that acute pleurisy with effusion, even when the effusion is small or moderate in amount, is, when complicated with disease, more especially acute disease (such as œdema, acute bronchitis, particularly of the smaller tubes) of the opposite lung, a condition of great danger. Double pleurisy with effusion is, for the same reason, a most serious condition. In such cases the operation of paracentesis is demanded when the amount of effusion is comparatively small. In a case of double (tubercular) pleurisy with effusion which was under my care in hospital some years ago, the patient died through the night, apparently from a rapid, but what, if it had been one-sided, would have been a comparatively trifling increase of the effusion on the side which was secondarily affected. It is probable, I think, that had the operation of paracentesis been performed in this case, and the fluid, which more than half filled the side which was first affected, been removed, the sudden fatal termination might have been prevented.

For all these reasons, therefore (because it entails danger to life, because it is apt to produce permanent damage to the lung, and because in some cases it interferes with the normal process of absorption, apparently by compressing the vessels and lymphatics in the pleural wall) a pleuritic effusion, which is sufficiently copious to produce positive intra-thoracic pressure, is an effusion which, speaking generally, demands active interference, and in the treatment of which paracentesis is indicated. *Vice versâ*, so long as the intra-pleural pressure remains negative, the operation is not necessitated by reason of the quantity of fluid which is present.

The statement which has just been made does not of course imply that paracentesis is only to be practised when the intra-pleural pressure has become positive, for, as I have more than once already pointed out, the operation is called for whenever urgent symptoms are associated with and apparently due to pleuritic effusion, whatever the stage of the disease, and whether the effusion is large or small in amount; in other words, whenever there are urgent symptoms due to pleuritic effusion, *quite irrespective of the condition of the intra-pleural pressure.*

It will be obvious from the foregoing remarks that the presence or absence of positive pressure within the pleural cavity is one of the most important elements in determining whether the operation of paracentesis should be performed or not. It is necessary, therefore, in the next place, to inquire what are the clinical indications, symptoms, and physical signs by which the presence of positive intra-pleural pressure, or in other words, the presence of an amount of pleuritic effusion which is exerting positive intra-pleural pressure can be determined.

The observations of Garland, Powell, and others have shown that so long as the lung retains its elasticity, in other words, so long as the intra-pleural pressure remains negative, the upper limit of the absolute dulness or flatness (as Garland and other American writers term it) which marks the upper level of the fluid, is not a straight or horizontal, but a curved line, such as is represented by the line to which the letter *d* points in Figs. 1

and 2; and that it is only when the effusion becomes so considerable as to overcome the elasticity of the lung and to convert the intra-pleuritic pressure from the normal (negative) into a positive pressure, that the curved (S-shaped) outline of the absolute dulness disappears, and its upper limit becomes horizontal, as is represented by the line to which the letter *c* points in Figs. 1 and 2.

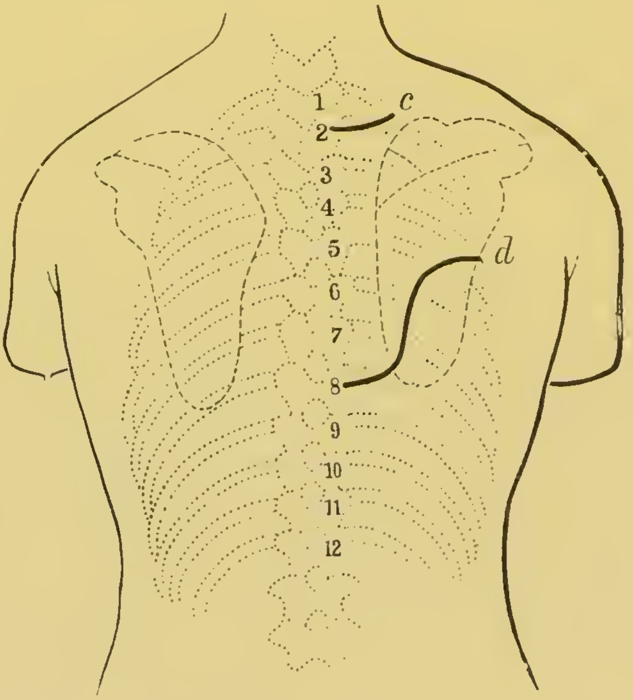

FIG. 1.—Back view of the chest in a case of acute pleurisy, with copious effusion, showing the outline and extent of the dulness before and after tapping. (After Garland.)

The letter *c* points to the upper level of the dulness before tapping; the letter *d* to the (S-shaped) curved line of the upper outline of the dulness after tapping.

The patient could not speak English, and so no history could be obtained on admission to hospital. The whole of the right side of the chest was flat, except the top of the shoulder and the clavicular region. The letter *c* points to the outline of the dulness. The heart was pushed to the left. The patient was tapped on October 4th, 1873, between the eighth and ninth ribs, near the lower angle of the scapula, and 84 ounces of clear serum were drawn off. During the latter part of the operation there was hard cough, which soon cleared. On November 2d the line of flatness was as shown in this figure, the line to which the letter *d* points. (*Pneumo-Dynamics*, by G. M. Garland, M.D., page 8).

My own observations corroborate those of Garland and

Powell as to the clinical fact that the outline of the upper limit of the dulness is, in the great majority of cases of recent pleurisy in which the effusion is moderate in amount, curved and not horizontal.

It must not, however, be supposed that the curved (or S-shaped) outline is invariable. As Garland has himself pointed out, the presence of pleuritic adhesions or abnormal conditions of the lung (such as emphysema or cirrhosis) which deprive it of elasticity will interfere with its production, and as Powell states,—and I can corroborate his statement from my own observations,—it is not always possible to demonstrate it, even in recent cases, in which the lung, so far as one can judge, has been previously free from disease.

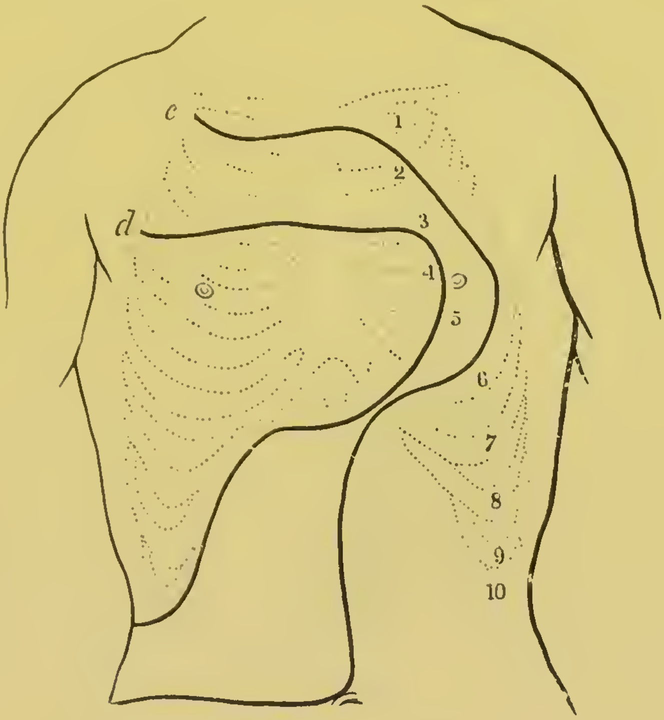

FIG. 2.—Front view of the chest in a case of acute pleurisy, with copious effusion, showing the outline and extent of the dulness before and after tapping. (After Garland.)

The letter *c* points to the outline of the dulness before, and the letter *d* to the outline of the dulness after tapping.

Further, in chronic pleuritic effusions and in cases of hydrothorax (in which the effusion is frequently of long duration, in which the normal elasticity of the lung is apt to be modified by associated conditions, and in which loss of tone in the diaphragm, and indeed in all the tissues, is usually present), the S-shaped outline of dulness is often absent even when the effusion is by no means extensive. In such cases, too, I have frequently found the lower lobe of the lung completely compressed and destitute of air, and the diaphragm depressed and the liver dislocated downwards into the cavity of the abdomen, when the pleuritic fluid was comparatively small in amount.

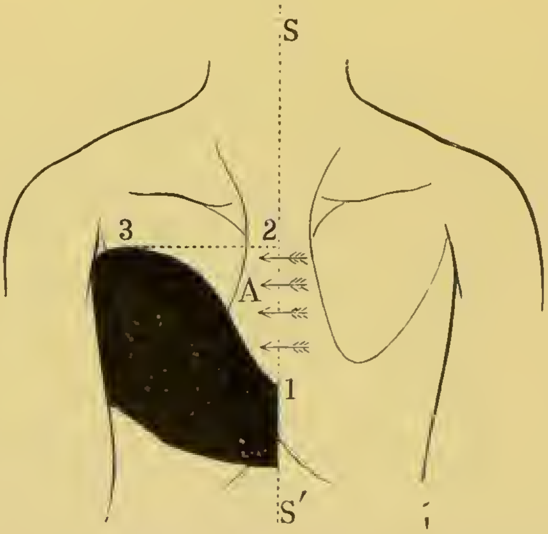

Fig. 3 —Diagram showing from behind the outline of the dulness in a case of pleuritic effusion, in which the effusion is not as yet sufficiently copious to produce positive pressure within the pleura, and in which the curved (S-shaped) outline of the upper level of the dulness is shown.

The letters S, S′, point to the middle line (spinal column). The letter A is placed, in Garland's triangle of resonance, at the angles of which the numbers 1, 2, and 3 are placed.

The arrows show the direction in which the percussion should be made, in order to define the triangle of resonance between the spine and the fluid.

In acute cases it is probable that the rapidity with which the fluid is poured out may exert some influence on the manner in which the lung behaves (contracts) as the fluid accumulates.

In mapping out the exact limits of the absolute dulness it is important to follow Garland's instructions, viz.:—(1.) to percuss lightly, so as to distinguish between absolute dulness (or flatness, as he terms it) and relative dulness or impaired resonance; (2.) to percuss at right angles to the spinal column, and at different levels (as shown by the arrows in Fig. 3), so as to determine the presence of the triangular area of resonance (A in Fig. 3.), which is situated between the spinal column on the one hand, and the line of absolute dulness which marks the limit of the fluid effusion on the other; and (3.) it is important to see that the patient takes a few long breaths before the percussion is practised, so as to fully inflate the portion of lung between the spine and the fluid. The presence of œdema in this portion of lung is probably one reason why the S-shaped outline of the dulness is not always present.

The fact, therefore, that the upper limit of the absolute dulness presents a curved rather than a horizontal outline, shows that the lung still retains its elasticity, and that the intra-pleural pressure still remains negative.

With regard to the quantity of effusion which is required to produce positive intra-pleural pressure, Douglas Powell states:— "My observations would lead me to assert that in recent cases the period of effusion at which intra-thoracic pressure is converted from a negative or zero into a positive pressure upon the lung and heart is marked clinically (1.) by the dulness mounting above the third cartilage (patient in sitting position), and (2.) by the Skodaic resonance becoming changed from the full note to a more tubercular quality, and finally becoming extinguished." [1]

The following, then, are the chief clinical indications that the effusion is so copious as to produce positive intra-thoracic pressure:—

(1.) Very extensive dulness.—According to Dr. Powell, dulness which mounts above the third cartilage when the patient is in the sitting position.

(2.) Disappearance of the Skodaic resonance above the level of the fluid.

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[1] *Diseases of the Lungs and Pleuræ*, page 88.

(3.) Disappearance of the S-shaped, curved outline of the absolute dulness which marks the upper level of the fluid, the line of dulness becoming horizontal.

(4.) Disappearance of Garland's triangle of resonance between the spine and the fluid. (See A, Fig. 3.)

(5.) Disappearance of Traube's triangle of resonance (see B, Fig. 4.), showing that the diaphragm and stomach are depressed.

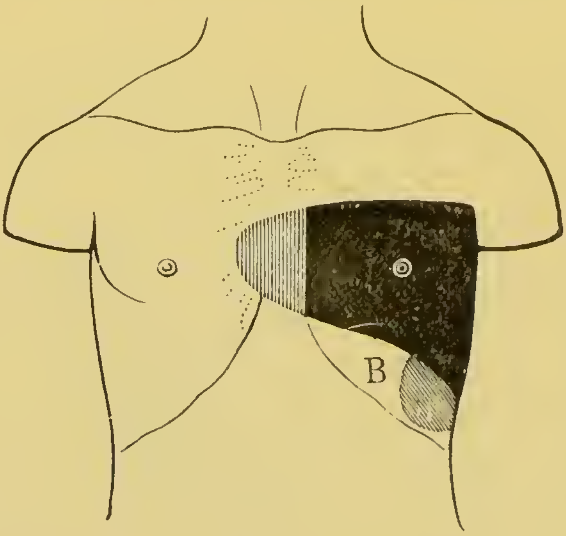

FIG. 4.—Diagram showing, from the front, the outline of the dulness in a case of pleuritic effusion, in which the effusion is not as yet sufficiently copious to produce positive pressure within the pleural cavity, and in which the arch of the diaphragm is still preserved.

The letter B is placed in Traube's triangle of resonance, which is formed by the stomach.

(6.) Great displacement of the heart. In some cases there is in addition a systolic basic murmur due to twisting, or perhaps more probably stretching and bending, of the great vessels (aorta and pulmonary artery).

(7.) Great enlargement of the thorax; widening of the intercostal spaces; and in rare cases (mostly cases of empyema in children) the presence of fluctuation in the intercostal spaces.

It may not be out of place to state here that in the management and treatment of cases of pleurisy with effusion daily systematic observations should be made, and methodical records kept with regard to the following points:—

(1.) The exact nature of the symptoms — (pain, cough, dyspnœa, orthopnœa, &c.).

(2.) The condition of the temperature, pulse, and respiration. (The results should be graphically recorded on a chart.)

(3.) The decubitus. It has been previously stated that with the occurrence of copious effusion the patient turns from the back or sound side on to the diseased side.

(4.) The upper level of the absolute dulness and the outline which it presents. The outline of the absolute dulness should be daily marked on the chest by means of an aniline pencil.

(5.) The position of the heart, and the position and extent of Garland's and Traube's triangles of resonance. (See Figs. 3 and 4.) Their respective outlines should be marked on the chest with an aniline pencil.

(6.) The relative measurements of the two sides of the thorax. In order that the daily measurements may be compared with one another, they must of course be always made through the same fixed point—say, for example, on the level of the nipple or of the fifth costal cartilage. The measurement is most satisfactorily made by means of the cyrtometer, which allows of the outline being transferred to paper and retained for future observation and comparison.

(7.) The condition of the opposite lung. As has been already pointed out, this is a point of the greatest practical importance. The exact condition of the opposite lung should be daily determined by percussion, auscultation, &c.

(8.) The condition of the heart and pericardium.

(9.) The condition of the urine. As has been previously pointed out, the commencement of the absorption period is sometimes marked by an increased flow of urine. *Vice versâ*, a sudden diminution of the urinary secretion, the presence of blood or albumen in the urine, or other indications of acute congestion or inflammation of the kidney, are, in a case of acute pleurisy with effusion, suggestive, if not actually indicative, of danger.

It is only by minute attention to these details that it is possible to determine with exactitude—(1.) the condition of the affected pleura, the variations which take place in the amount of effusion, and the effects which the effusion is producing in the lung of the affected side; (2.) the condition of the lung and pleura on the opposite side; (3.) the condition of the heart; (4.) the general condition of the patient—all of which are of the greatest practical importance both for the purposes of prognosis and treatment.

To sum up, the following rules may be laid down as the chief indications which should guide the physician in deciding whether the operation of paracentesis is required; and if so, when it should be performed :—

1. As a general rule, the operation should not be performed until the febrile symptoms have subsided.

2. There is no absolute need of paracentesis so long as there are no urgent symptoms, and so long as the physical signs indicative of positive intra-thoracic pressure (see page 25) are not present.

3. The operation is indicated, whatever the stage of the disease, and whatever the condition of the intra-pleural pressure (whether negative or positive), when urgent or dangerous symptoms, apparently due to the pleuritic effusion, are present.

4. When the amount of effusion is so large as to produce positive intra-thoracic pressure, the operation is indicated, whether urgent symptoms are present or not. If the chest is full, or two-thirds full of fluid, the operation should be performed as soon as possible ; for, under such circumstances, it is possible that a few hours delay may be attended with danger.

5. Disease in the opposite lung, marked embarrassment of the respiration, the physical signs of congestion or œdema in the sound lung, blood-stained sputum, increased dyspnœa, not accounted for by increased effusion on the diseased side; signs of interference with the circulation, such as cyanosis, venous congestion, anæmia, a tendency to faint, or a quick, weak,

irregular pulse, or the occurrence of acute pleurisy on the opposite (and previously healthy) side, are indications that the operation should be performed even when the effusion is moderate or comparatively small in quantity.

6. If natural absorption does not commence within a reasonable time (say at the end of the third week of the disease) the operation is indicated.

7. A diagnostic puncture should be practised in those cases of pleurisy with effusion in which the fever does not subside at the end of a fortnight. This is especially important in children, in whom the effusion is so often purulent.

Contra-indications.—Serious disease, such as well-marked phthisis in the lung of the affected side, is considered by most authorities as a contra-indication to the operation. I have no personal experience to offer on the point. When pleurisy does occur in the course of phthisis, it is usually dry and localised. I do not remember to have met with any case of well-marked (advanced) phthisis in which an effusion sufficiently copious to suggest paracentesis occurred on the side of the diseased lung. I have, however, more than once punctured the chest, but, as might be expected, without any lasting benefit in cases in which pleuritic effusion, both sero-fibrinous and purulent, has been associated with solid intra-thoracic growths.

It is said that when the lung on the affected side is diseased the operation should be avoided, unless the urgency of the symptoms makes its performance absolutely necessary, since such cases as a rule do badly.

Further, it has been thought that the presence of fluid in the pleura, and the functional and vascular alterations in the lung which it produces, may retard the active development of the pulmonary lesion, just as air in the pleural cavity is thought to do, and that the occurrence of pleurisy with effusion in cases of phthisis may consequently prove rather beneficial than the reverse. If such an effect is actually produced, the question arises whether pleuritic effusion should not be artificially produced in cases of phthisis, with the object of arresting the progress of the pulmonary lesion.

It is also said that advanced age, the facts that there is no reasonable hope of recovery and that the pleurisy is associated with incurable organic lesions, or with complications, which will in all probability prove fatal, are contra-indications to the performance of the operation. The rule which I have laid down for myself under such circumstances is to perform the operation when it seems likely either to prolong the life or relieve the sufferings of the patient. When the pleurisy is associated with incurable disease, the paracentesis should not of course be performed when the operation itself is likely to be attended with immediate danger.

The method of performing the operation.—The exact manner in which the operation is to be carried out depends chiefly upon (*a*) the nature of the fluid (whether sero-fibrinous or pus); (*b*) the manner in which the fluid flows during the operation; and (*c*) the condition of the lung on the affected side.

The exact nature of the fluid can only be certainly determined by means of the diagnostic puncture, but unless the condition of the temperature or other circumstances (see page 53) lead the physician to suspect the presence of pus, a diagnostic puncture is not usually necessitated. In such cases (*i.e.*, when a diagnostic puncture has not been performed) it is only during the operation itself that the exact character of the effused fluid is with certainty determined.

In considering the method of operation, the following facts should be kept in view:—

Firstly. That in the great majority of cases of ordinary simple (sero-fibrinous) pleurisy, the removal of a comparatively small quantity of fluid is all that is required. Unless there are urgent and special reasons to the contrary—such, for example, as (1.) the very rapid effusion of a large quantity of pleuritic fluid, with very urgent symptoms, conditions which may occur in the very severe but rare (*foudroyant*) cases of the disease; or (2.) the occurrence of acute pleurisy with effusion on the sound side, in a case in which the other pleural cavity has been previously affected, and contains a considerable quantity of pleuritic fluid—the amount of fluid which is withdrawn at any one operation (sitting) should not (in cases of simple sero-fibrinous pleurisy) usually exceed 30 or 40 ounces; for the rapid alteration in the intra-thoracic pressure which results from the removal of a large quantity of fluid is undoubtedly apt to be attended with danger (*i.e.*, with the risk of producing syncope or embolism by detaching coagula in the lungs or heart).[1]

Secondly. That the fluid should be withdrawn very slowly and gradually. It may be laid down as a general rule that the smallest cannula should be used which will allow the free flow of the effused fluid, and that if the aspirator is employed for the removal of the fluid, case should be taken not to exert any powerful suction upon the contents of the thorax.

The rapid withdrawal of a large quantity of fluid by means of a large trocar and powerful suction force, is to be strongly deprecated. The sudden alteration in the intra-thoracic pressure and the disturbance of the circulation within the chest, which results therefrom, may undoubtedly lead to the occurrence of congestion or œdema in the opposite lung—a condition which is in some cases attended with the expectoration of a large quantity of albuminous or blood-stained sputa—to the production of embolism (from the detachment of clots either in the heart or pulmonary vessels), or to the occurrence of fatal syncope. Indeed it seems certain that some of the deaths which have occurred during the operation have been due to the too rapid and forcible withdrawal of the fluid.

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[1] Fräntzel advises that not more than 2½ pints, Dieulafoy not more than 1000 grammes, and Donaldson not more than from 8 to 16 ounces in the child, or 12 to 24 ounces in the adult, should be removed at one time. Donaldson states that by connecting a manometer with the aspirating apparatus, we can accurately observe the effect which the operation is producing upon the intra-thoracic pressure, and can so determine whether it is advisable to remove one, two, or three pints of fluid at one time.—Pepper's *System of Medicine*, vol. iii., page 531.

Whether aspiration or the syphon method are used, the operation should be at once suspended and the cannula withdrawn, if constrictive pain, cough, cyanosis, fainting, or any other untoward symptoms arise.

With a small cannula (No. 2) and Potain's aspirator the suction force can be accurately regulated by means of the tap between the exhausted bottle and the cannula, more especially if only a small quantity of fluid be withdrawn. If these precautions are observed—(1.) small cannula; (2.) regulation of the aspirating force by means of the tap; (3.) withdrawal of a limited quantity of fluid at one time—Potain's aspirator is, I believe, a perfectly safe and satisfactory method of operating, and it is the one which I am personally in the habit of employing.

Withdrawal of the fluid by syphon action is another very satisfactory method in many cases, and is recommended by many leading authorities. The trocar and cannula figured by Douglas Powell, and the small aspirating instrument introduced by Foulis, are admirably suited for withdrawing the fluid in this (syphon) manner.

"In using the syphon action for the withdrawal of the fluid, it must be remembered that a fluid cannot be drawn off by a cannula unless air enters to replace the fluid; unless the pressure on the fluid from within the cavity is greater than that of the atmosphere, we cannot draw off a large quantity; if the pressure balances that of the atmosphere, only a few drops of fluid are discharged externally except by forced expiration and coughs. This is the case even when the quantity reaches several litres. The feebler the expiratory force the less fluid escapes."[1]

Thirdly. The strictest antiseptic precautions must invariably be used. The skin at the point of puncture should be first washed with soap and water, and then thoroughly cleansed with carbolic or corrosive sublimate solution. The trocar and cannula should be thoroughly cleaned with corrosive sublimate solution, and then rinsed out with distilled or boiled water. Those portions of the trocar and cannula which are to be thrust into the chest should, as an additional precaution, be passed through the flame of a spirit lamp (Douglas Powell points out that discoloration of the instrument may be prevented by oiling it before passing it through the flame). Finally the instrument should be slightly greased with a solution of carbolic acid in glycerine—perhaps a more reliable disinfectant than the carbolic oil which is usually employed.

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[1] Pepper's *System of Medicine*, vol. iii., page 505.

Point of puncture.—In selecting the point of puncture, our object is to choose a place at which the instrument may be introduced into the cavity of the pleura without the risk of wounding the lung on the one hand, or the heart or diaphragm on the other. In simple (sero-fibrinous) effusions, a point should be selected which is central as regards the effused fluid, at which, so far as can be judged, there are no adhesions, and at which the cannula is not likely to become choked up by thick flocculi of lymph.

The sixth interspace, in the mid-axillary or posterior axillary line, is the position which I am usually in the habit of selecting, unless there is any obvious reason, such as the probable presence of adhesions, to the contrary. Douglas Powell recommends the sixth interspace in the posterior axillary line for the following reasons:—" This spot," he says, " is most convenient, because —(1.) most accessible whilst the patient is reclining in an easy posture; (2.) the parietes are here moderately thin, and the intercostal space sufficiently roomy; (3.) the mamma in the female is out of the way; (4.) we are sufficiently high to be free from the danger of wounding the diaphragm; (5.) this spot has the advantage over that most commonly chosen, below the angle of the scapula, in there being less probability of the cannula being blocked by flocculi, which tend, from the position of the patient, to gravitate towards the back of the chest; most of the dry tapping," he states, " which I have observed, have occurred with the posterior puncture; (6.) this spot has the advantage over the one chosen more anteriorly, in being more central with regard to the effusion."[1]

In tapping localised and limited effusions, the puncture should be made, so far as possible, over the centre of the effusion, granting of course that there are no other indications to the contrary. The position which should be selected in cases of empyema will be afterwards considered.

Local anæsthesia.—Before introducing the trocar, it is usually advisable to deaden the sensibility of the skin and underlying parts. For the production of local anæsthesia Douglas Powell recommends that "a piece of ice with a flat surface an inch or two square, dipped in salt, should be applied with firm pressure to the spot marked for puncture. In twenty or thirty seconds the spot will be frozen; it should then be rapidly wiped, a small incision made through the skin, and the trocar previously steeped in carbolic acid solution (1 to 40) thrust through the pleura."

The subcutaneous injection of a third or a quarter of a grain of cocaïne is probably better than freezing, since it more effectually deadens the sensibility of the underlying parts.

In phlegmatic individuals the production of local anæsthesia is not perhaps necessary, for the pain produced by the introduction of a small-sized trocar and cannula is not in reality very much greater than that which attends the use of the hypodermic syringe. Nevertheless the production of local anæsthesia by ice or cocaïne is, I think, a desirable procedure in most cases. In nervous persons, and in patients debilitated by disease, the mental pain, and consequent constitutional disturbance (collapse, sweating, cardiac debility, &c.) produced by the anticipation, often far exceed the local pain and resulting constitutional disturbance produced by the actual operation (puncture) itself. By assuring the patient that the pain of the operation will be for the most part prevented by the production of local anæsthesia, and (if cocaïne be used) by showing him the tiny hypodermic syringe, and explaining to him that the pain attending its introduction will constitute the chief part of his suffering, his dread of the operation and the consequent constitutional disturbance are reduced to a minimum, more especially in those cases in which he has had previous experience of the use of the hypodermic needle.

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[1] *Diseases of the Lungs and Pleuræ*, page 107.

To sum up, the following are the chief points to which attention should be directed in performing the operation of paracentesis:—

(1.) Place the patient semi-recumbent, so that the part of the chest which is to be punctured is conveniently near the edge of the bed; and direct the nurse to raise and support the arm, so as to widen the intercostal spaces.

Should it be thought desirable to introduce the instrument with the patient in the sitting position, he should be made to recline in the semi-recumbent position while the fluid is being withdrawn.

(2.) Thoroughly disinfect the trocar and cannula and the skin at the point of puncture. Before puncturing the chest, see that the apparatus is in working order, by drawing through it, with cannula attached, a stream of carbolic solution.

(3.) Count the intercostal spaces from above downwards, and mark the spot at which the trocar is to be introduced.

(4.) Percuss and auscultate over the position of the proposed puncture, and satisfy yourself that the lung is not adherent at that point.

(5.) Deaden the sensibility of the skin at the point of puncture either by ice (Powell's method) or by the subcutaneous injection of cocaïne.

(6.) Introduce the trocar and cannula with a firm plunge. If a large needle is to be used, a preliminary incision through the skin with a sharp bistoury is advisable, but in ordinary simple (sero-fibrinous) effusions, where the needle should be small, a preliminary incision is, I think, unnecessary. The trocar should at first be directed directly inwards, and after the pleural sac is entered slightly downwards and inwards.

After the trocar and cannula are introduced, the tubing connected with the aspirator or syphon must be attached; the trocar withdrawn; and the stop-cock (No. 1) which shuts off all communication between the cannula and the external atmosphere closed.

(7.) Gradually open the stop-cock (No. 2) which shuts off the connection between the cannula and the bottle of the aspirator, the air in the bottle having been previously exhausted.

(8.) Withdraw the fluid very slowly, and take care that no powerful suction action is exerted upon the intra-thoracic contents.

(9.) Unless there is some special reason to the contrary, withdraw only a small quantity of the effused fluid (20, 30, or 40 ounces).

(10.) If fluid fails to flow when the full suction influence of the exhausted bottle is brought to bear, the position of the cannula should be altered (since the point of the instrument may be buried in an adhesion and have failed to reach the fluid.) If after such manipulation, fluid still fails to flow, the aspirator should be disconnected and the cannula withdrawn.

(11.) If the cannula is found to be pervious, and the physician feels sure of his diagnosis, the instrument should again be introduced at some other, but adjacent, part of the chest. If there is any reason to suppose that the fluid is too thick to flow through the cannula which was first used, a larger instrument should subsequently be introduced.[1]

(12.) If constrictive cough, pain, faintness, dyspnœa, or any other untoward symptoms arise, the aspiration should at once be stopped, the cannula withdrawn, and a stimulant administered.

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[1] The tapping may be dry in consequence of (1.) defects in the instrument; (2.) errors in diagnosis (a solid pneumonically consolidated lung with obstructed bronchi, or a solid intra-thoracic tumour, are the conditions with which pleuritic effusions are most likely to be mistaken); (3.) the fact that the instrument has been plunged into a tough band of adhesions, or into the lung itself at a point where it is adherent; (4.) the circumstance that the cannula has become plugged with flocculi of thick lymph, or, when a very small instrument is used, that the fluid is too thick to flow freely through it.

(13.) If the fluid which flows through the cannula is blood, the aspiration should also be arrested.

(14.) If the fluid is pus, as much as may seem advisable should be withdrawn, and the treatment of the case conducted in a manner which will be subsequently described in connection with empyemata.

(15.) After withdrawing the cannula, the opening should be closed with collodion, or a piece of lint should be fixed by means of strips of adhesive plaster over the superficial wound.

The subsequent treatment of the case.—In all cases after the performance of paracentesis, absolute rest in the recumbent position is essential, and the patient should be directed to lie as quiet as possible for several hours.

Should the patient feel faint during or immediately after the operation, a stimulant (brandy, whisky, &c.) should be administered.

For at least twelve hours after the operation, the diet should consist of liquid food. Unless there is any reason to the contrary, the same remedies which were being administered before the operation should be continued.

The temperature should be carefully observed at frequent short intervals—every six or eight hours after the operation; if any fever develops, 5 to 10 grains of quinine should be administered, or a febrifuge mixture (liquor ammoniæ acetatis and sweet spirits of nitre) prescribed.

Some German authorities recommend that a more active antiphlogistic plan of treatment should be adopted in all cases. Thus Fräntzel approves of Traube's recommendation, viz., "to apply to the place of puncture, twice in twenty-four hours, an india-rubber bag containing powdered ice, entirely without reference as to whether the patient suffers pain or not after the operation." By this means he thinks that the recurrence of a fresh effusion is prevented, and the danger of a simple sero-fibrinous pleurisy being transformed into a purulent effusion is prevented. "Thus," he says, "we must endeavour to cause contraction of the walls of the vessels distended by inflammation, and inclined, after the removal of the pressure caused by the pleuritic effusion, to allow of emigration of lymph corpuscles and greater effusion." He adds, "How very necessary this antiphlogistic treatment is, is best illustrated by the fact that very often after puncturing, patients without fever become feverish for a day or two, and in feverish cases a moderate rise of temperature takes place, while even the effusion increases not inconsiderably. But," he adds, "as a rule the effusion soon comes to a standstill, and in simple pleuritis absorption very quickly sets in." [1]

If after the operation the patient should complain of pain at the seat of the puncture, a mustard plaster or blister may be applied, or a subcutaneous injection of morphia administered. Such measures are, however, very rarely required.

During the subsequent progress of the case (while absorption of the effusion is being naturally effected)—and this statement applies to all cases of pleurisy with effusion (*i.e.*, whether the operation of paracentesis has been performed or not)—the patient should be directed every now and again (several times in the twenty-four hours) to cough and make expiratory efforts with the mouth and nose closed, so as to aid the expansion of the compressed lung, to prevent its being fixed down by adhesions, and to actively assist the removal of the effused fluid by the lymphatics. The inhalation of compressed air is also strongly recommended by some authorities for the same purpose (see Ziemssen's "Handbook of General Therapeutics: Respiratory Therapeutics," page 703).

The repetition of the operation of Paracentesis.—If after the first puncture the fluid rapidly increases, the operation must be again performed if the symptoms again become urgent, or the amount of effusion sufficiently great to endanger life. In rare cases it may be necessary to repeat the operation again and again at short intervals. In deciding whether more than one repetition of the operation is advisable, the physician must of course be guided by the special circumstances of each individual case. He has to weigh the dangers which the patient runs from the reaccumulation of the effusion against the risks of repeated operations and the exhaustion which is in some cases produced thereby. Fräntzel states that, "if the pleuritic effusion rises continuously after paracentesis, and is attended with high fever, there is strong reason to suspect, apart from the other symptoms, that the effusion is hæmorrhagic or purulent."[1]

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[1] Ziemssen's *Cyclopædia of Medicine*, vol. iv., page 712.

Subacute Pleurisy with Effusion.

In many cases of subacute pleurisy with simple (sero-fibrinous) effusion there are few, if any, symptoms suggestive of the condition. A considerable effusion may accumulate so gradually that there may be no cough, and no shortness of breath, unless the patient exerts himself, but, as has been already pointed out, such cases are by no means devoid of danger.

In treating cases of this description, the patient should be sent to bed as soon as the true nature of the condition is discovered; the temperature should then be noted, a careful cyrtometer measurement of the chest made, the amount of fluid, the presence or absence of positive intra-thoracic pressure, and the condition of the lung, both on the affected and on the sound side, determined in the manner previously described (see page 31).

When the effusion is so copious as to produce positive intra-thoracic pressure, the operation of paracentesis should not be delayed, more especially in those cases in which there has been any—even temporary—dyspnœa.

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[1] Ziemssen's *Cyclopædia of Medicine*, vol. iv., page 714.

When there is reason to suspect from the history that the case is of several weeks' duration, paracentesis is also indicated, lest the further continuance of the effusion may lead to fixation and permanent non-expansion of the lung.

When the immediate performance of paracentesis does not seem indicated, the local and internal remedies, which the special circumstances of the case seem to demand, for promoting absorption of the effused fluid should be employed; careful cyrtometer measurements should be made from time to time, and if in the course of a few days natural absorption does not take place, the operation of paracentesis should be performed.

In dealing with cases of this description, the fact that subacute and chronic pleuritis with effusion are not infrequently bilateral should not be forgotten.

Chronic Pleurisy with Effusion.

In chronic pleurisies with effusion, which are more frequently left than right side, the fluid may be simple (sero-fibrinous) or purulent.

In the former the non-absorption of the effusion may be due to any of the constitutional defects or local conditions which have already been enumerated as causes of non-absorption in acute cases (see page 15).

In dealing with cases of chronic pleurisy with effusion, the first object of the physician should be to determine by means of the diagnostic puncture whether the fluid is purulent or simple.

If the fluid is purulent the lung will in all probability be more or less tied down by adhesions. The method of treatment which should be adopted in cases of this kind is described on pages 57 and 67.

If there is reason to suppose that the lung is still capable of expansion, the case must be treated in accordance with the rules laid down on page 57.

Cases of chronic pleurisy with sero-fibrinous effusion must be treated on the plan described on page 16. It must be remembered that when the effusion is copious and of long duration the lung may be so firmly tied down by adhesions that it cannot expand even if the fluid is removed. Whether the lung is adherent in this manner or not can only be determined by observing the effects which are produced by withdrawing a portion of the fluid. In performing the operation of paracentesis under such circumstances—in cases of copious chronic simple (sero-fibrinous) effusion—the necessity of withdrawing the fluid very slowly and with a minimum of suction force is of the utmost importance, for if the lung be incapable of expansion, and if powerful suction (aspirating) force be used, serious symptoms and even fatal results may ensue. The operation should at once be suspended if constrictive pain, cough, dyspnœa, or faintness arise. When the slow withdrawal of only a small quantity of fluid is attended with the production of such symptoms, it is reasonable to conclude that the lung is extensively adherent, and to a large extent incapable of expansion. In such circumstances (a large, *simple*, chronic effusion, with extensively adherent lung) the most judicious treatment is probably to abandon any further attempt to withdraw the fluid by artificial means, and to trust to constitutional treatment (diet, drugs, especially cardiac and general tonic) and counter-irritation. Large, simple (sero-fibrinous) effusions of long duration rarely, however, come under observation, and the physician is consequently seldom placed in the difficult position which has just been indicated.

TUBERCULAR PLEURISY.

The inflammations of the pleura which so frequently occur in the course of phthisis are in the great majority of cases localised and dry; and it is only exceptionally that in such cases any considerable amount of sero-fibrinous effusion is poured out into the pleural sac. When tubercular deposits are more generally diffused throughout the body, they are frequently deposited in the pleural membrane, and in some cases of this kind, as in rare cases of phthisis, the pleuritic inflammation may be accompanied by very considerable effusion.

Tubercular pleurisy with effusion is to be treated on the same general principles as the simple variety; indeed in many cases it may be impossible in the earlier stages to come to any positive conclusion as to the exact causation of the attack, though from the constitutional characteristics of the patient, his hereditary history, or the presence of well-marked tubercular lesions in some other part of the body, the physician may strongly suspect that the pleuritic inflammation is tubercular rather than simple in character.

In all cases of pleurisy with effusion in which absorption does not proceed in the usual normal manner, in cases of subacute and chronic pleurisy with effusion, and in cases of double pleurisy more especially, the physician should suspect that the inflammation is associated with the presence of tubercular deposits.

In tubercular pleurisies the effusion is generally sero-fibrinous, but in those cases in which the condition is associated with phthisis the effusion is apt to be purulent. Empyemata due to the rupture into the pleura of superficial abscess cavities on the surface of the lung are often, of course, complicated with pneumothorax. (See the treatment of pyo-pneumothorax.)

Double Pleurisy with Effusion.

As has been remarked above, double pleurisy with effusion is often tubercular, sometimes cancerous, and not infrequently septic. In septic cases the effusion is apt to be purulent. According to some observers, rheumatic pleurisies are sometimes bilateral.

Double pleurisy with effusion is, as has been already pointed out, a condition of great danger, and one in which the early performance of paracentesis is called for.

HÆMORRHAGIC PLEURISY.

In the earlier stages of almost all cases of acute pleurisy, blood corpuscles can be detected by means of the microscope in the effused fluid. In some cases the blood corpuscles are so numerous as to give the effused fluid a distinctly brown or reddish tinge; it is said that in such cases the pleural inflammation is usually very severe. I have seen some cases which appear to support, others to contradict this view. It is only when the effused fluid is so largely composed of blood that it looks distinctly bloody to the naked eye, that the pleurisy can be properly termed hæmorrhagic.

True hæmorrhagic pleurisy is usually tubercular, cancerous, or associated with purpura, scurvy, the hæmorrhagic diathesis, or some depraved condition of constitution.

If a pleurisy which was at first simple becomes distinctly hæmorrhagic in character, it is usually associated with cardiac or renal disease, alcoholismus, or some of the conditions which have just been enumerated (scurvy, purpura, the hæmorrhagic diathesis, &c.).

In some cases of hæmorrhagic pleurisy there is, it is said, a special delicacy of the newly formed vessels, which renders them specially liable to bleed. It has also been thought that some cases of hæmorrhagic pleurisy are perhaps due to the formation of a highly vascular tissue on the surface of the pleura, similar to that met with in pachymeningitis hæmorrhagica—a condition to which, it will be remembered, alcoholic excess seems to predispose.

Well-marked cases of hæmorrhagic pleurisy are rare. When the effused blood is poured out rapidly the symptoms may be urgent and to some extent characteristic. Rapid loss of strength, and marked pallor of the skin and mucous membranes occurring in the course of a severe attack of acute pleurisy, and associated with high fever and a considerable degree of pain in the side, are suggestive that the pleurisy is hæmorrhagic. So, too, are marked weakness, pallor, pain in the side, and fever, occurring in the course of a subacute or chronic pleurisy with effusion, more especially when there is reason to suppose that the pleurisy is tubercular or cancerous.

But whether the effusion is hæmorrhagic or not, can only be definitely determined by means of the diagnostic puncture.

In the treatment of hæmorrhagic pleurisy, the same general principles must guide us as in the simple (sero-fibrinous) variety. Special measures (such as the internal administration of ergot or hazeline, and the local application of cold in the form of ice bags to the chest) must also be adopted with the object of arresting the hæmmorhage.

In hæmorrhagic cases paracentesis should only be performed when the symptoms are so urgent that the removal of some of the effused fluid seems essential for the prolongation of life. Should the operation be deemed necessary, the strictest antiseptic precautions must of course be observed, and the greatest care taken that no air is allowed to find its way into the pleural sac.

PART II.

THE TREATMENT OF EMPYEMA.

The fundamental point which must always be kept in view in dealing with empyemata is that a purulent collection within the thorax should be as speedily and as thoroughly evacuated as possible. Hence early recognition of the fact that the effusion is purulent, and prompt operative interference, as soon as its purulent nature is definitely ascertained, are the principles which should guide the physician in dealing with cases of this description.

These principles of treatment are based upon the following facts and considerations:—

1. That purulent collections within the pleura are very rarely, if ever, removed by the natural process of absorption.

2. That an empyema tends to evacuate itself either by bursting into the lung (bronchi), externally, or into the pericardium or some of the hollow viscera.

3. That the process of natural evacuation is often imperfect and unsatisfactory, and apt to be attended with very serious results, such as—(*a.*) suffocation, where a large bronchial perforation occurs suddenly during sleep; (*b.*) prolonged suppuration, with all its attendant evils (exhaustion, hectic, waxy disease, &c.); (*c.*) septic decomposition in the pleural cavity, in those cases in which septic materials or septic-carrying air finds its way into the cavity; (*d.*) the production of serious inflammatory complications in the adjacent viscera (pericarditis, peritonitis, &c.).

4. That where a collection of pus is allowed to remain for any length of time within the pleural cavity, permanent damage to the lung is very apt to result.

5. That in those cases in which caseous material remains in the pleural cavity, as the result of the imperfect evacuation and drying up of an empyema, it is apt to form the starting-point, at some future and it may be distant period, of general tuberculosis.

Early operative interference is most important, for the following reasons :—

Firstly. Although in the great majority of cases natural evacuation (either into the lung, externally, or elsewhere) is a late event, rarely occurring until some weeks after the effusion has formed, yet this is by no means always the case; in children more especially, the pus may make its way into a bronchus or elsewhere at a comparatively early stage of the case.

Secondly. The success of the operation, or at all events the perfectness of the cure and the ease with which a cure is obtained, depend to a large extent upon the condition of the lung, whether it is bound down by adhesions or not,—in other words, upon the duration of the case, for the longer the pus remains in the pleural cavity the greater is the risk of the lung becoming firmly adherent and compressed.

Now, since the early evacuation of an empyema is of so much importance, it follows that the physician must endeavour to recognise the purulent character of the effusion as soon as possible. It is desirable, therefore, in the next place to consider the circumstances under which pleuritic inflammations tend to produce pus, and the manner in which a purulent effusion is to be distinguished from the simple (sero-fibrinous) variety.

It is perhaps unnecessary to remark that the mere presence of a certain number of leucocytes (pus corpuscles) in the effused fluid does not constitute an empyema; for in every sero-fibrinous effusion numbers of leucocytes and corpuscles, which it is impossible to distinguish from pus corpuscles, are found on microscopical examination. It is only when the pus corpuscles become so numerous as to constitute the chief constituent of the effused fluid, and to make it look milky, thick, or purulent to the naked eye, that the case can be correctly termed an empyema. The distinction is of real practical importance, for there is in all probability a radical and essential difference between the two forms of inflammation—in the adult at all events. It is doubtful whether in a healthy (previously healthy) individual an ordinary simple pleurisy with effusion ever becomes purulent unless organisms are introduced into it; and also whether the mere long continuance of a pleuritic effusion (even in those cases in which, owing to some defect or deterioration of the general health, absorption does not take place) tends to transform simple (sero-fibrinous) fluid into pus. As a matter of fact, pleuritic effusions are apt to become purulent under the following conditions:—

(1.) *In children.*—Possibly in consequence of an innate tendency for all inflammatory exudations in the child to become purulent; probably in some cases from the fact that the pleuritic inflammation has its starting-point in a patch of catarrhal, caseous, or purulent pneumonia on the surface of the lung.

(2.) *In connection with septic diseases and cachectic conditions.*—Pleuritic inflammations arising in the course of puerperal fever, pyæmia, typhoid fever, and other septic conditions are apt to result in the formation of a purulent rather than a sero-fibrinous exudation.

(3.) *In consequence of the direct introduction of septic materials from without.*—Puncturing the chest with a dirty (septic) trocar was doubtless, before the introduction of the Listerian method, a much more frequent cause of a simple (sero-fibrinous) effusion becoming purulent than it is now. The absolute necessity of adopting the most stringent antiseptic precautions in dealing with all such cases has been previously emphasised.

In those pleurisies which arise in the course of phthisis, as the result of perforation of a cavity on the surface of the lung, the effusion is usually purulent. In many cases of this kind, as has been previously mentioned, there is not merely an empyema, but a pyo-pneumothorax.

(4.) *In consequence of debility, previous disease, or perhaps some peculiarity of constitution.*—In persons who are debilitated by previous disease the tendency to an inflammatory effusion becoming purulent is undoubtedly greater than in persons who have been previously healthy. It must by no means, however, be supposed that an effusion is usually purulent when a person who is debilitated by previous disease is attacked with pleurisy. The very reverse is in fact the case. In typhoid and scarlet fever, for example, the effusion is often sero-fibrinous, though the tendency to its being purulent is undoubtedly much greater in such conditions than in ordinary cases. In Bright's disease, more especially the cirrhotic variety, the effusion is very generally sero-fibrinous; in waxy disease it is, I think, more apt to be purulent.

In some adults, as in children, there seems to be a tendency to the effusion becoming purulent without any of the (obvious) causes or conditions which are usually associated with the production of empyema. Possibly, in some cases of this kind, the condition has its starting-point in a localised (purulent) or catarrhal pneumonic process in the pulmonary tissue, extending to the surface of the lung and invading the pleura. In other cases in which there is no obvious local cause for the condition, it is possible that septic or other germs which have the power of exciting suppuration are circulating in the blood, and find a suitable field for their operations in the inflammatory process in the pleura, which owes its origin to cold or some other condition.

It is said that when a relapse occurs in ordinary simple (sero-fibrinous) pleurisy the effusion is apt to become purulent. In many cases of this kind (but they are by no means common) there is in all probability no relapse properly so called,—that is to say, no mere return or renewal of the original (simple) inflammatory process. It seems more probable that the aggravation of the symptoms is due to the introduction into the pleural sac, from some source or another, of a septic pus-producing material, with the result that a different form of inflammation is produced, that the effusion becomes purulent, the temperature rises, and the symptoms are aggravated.

As regards the *differential diagnosis* of a simple (sero-fibrinous) pleurisy and an empyema, it may be at once stated that the only certain means of distinguishing the two conditions is an exploratory puncture; for although in some cases the formation of pus is attended with well-marked symptoms (a suppurative temperature, rigors, sweatings, &c.), these clinical indications are by no means always present. A diagnostic puncture is attended with little pain; and, provided that the needle is absolutely aseptic, it is an absolutely safe proceeding and a certain means of determining the exact character of the fluid. Two cautions only must be insisted upon—*firstly*, the needle must not be too small, for if the pus is thick and curdy, it may not flow through a needle of the smallest size; and *secondly*, the needle and syringe used for the diagnostic puncture should, after having been thoroughly disinfected with carbolic acid or other disinfecting solutions, be well washed out with boiled or distilled water, for should any carbolic solution remain within the needle or syringe, the clear (sero-fibrinous) fluid which is withdrawn may be rendered turbid and may appear to be purulent. It is hardly necessary to add that this source of fallacy may be avoided, and the exact character of the fluid withdrawn by the diagnostic puncture may with certainty be determined, by means of the microscope.

The clinical symptoms, physical signs, and associated conditions which are suggestive (though not absolutely conclusive) that the effusion is purulent, are as follows:—

(1.) *Great elevation of temperature* (more especially sudden rises and rapid falls, when associated with repeated rigors and sweatings) is very suggestive, though not absolutely conclusive. In purulent effusions the pulse is usually quicker, the depression and emaciation greater, and the tongue more apt to become dry than in ordinary simple (sero-fibrinous) cases.

(2.) *Local elevation of temperature.*—The fact that the local temperature of the affected side of the chest is distinctly elevated (one or two degrees higher than that on the sound side) is very suggestive of empyema; for in ordinary simple (sero-fibrinous) effusions such local elevations are not usually observed.

(3.) *Œdema of the wall of the chest on the affected side.*—This is very suggestive, though not absolutely conclusive, that the effusion is purulent. Local, subcutaneous œdema of the affected side is not, however, present in all cases of empyema. To detect the presence of local œdema, the skin of the lateral aspect of the chest in the infra-axillary region should be pinched up between the finger and thumb, first on one side of the thorax and then on the other. Œdema of the chest wall on the affected side is occasionally present in cases of simple (sero-fibrinous) pleurisy, in which there is a tendency to, or the presence of, general dropsy, and in which the patient has (as is often the case where the effusion is copious) been lying for some time on the affected side.

(4.) *Impaired conduction of the voice sounds* (*Bacelli's sign*).—Professor Bacelli pointed out some few years ago that the voice sounds are better conducted through simple (sero-fibrinous) homogeneous than through purulent effusions. In some cases this is doubtless the fact, but the sign is by no means always reliable, and hence is very much less important than its discoverer supposed.

(5.) *Intercostal fluctuation.*—Fluctuation in the intercostal spaces is an important indication of empyema; but it is a physical sign which is comparatively rarely met with. It is more frequently observed in children than in adults, and especially in those cases in which the purulent collection is of large size, and has been present for a considerable time.

Pulsating empyemata are usually localised, and generally situated in the immediate neighbourhood of the heart; there is (?) usually a communication between the sac of the pericardium and the abscess formation in the pleura.

(6). *Pain in the affected side.*—In simple (sero-fibrinous) pleurisies the pain usually subsides and entirely diappears with the occurrence of a copious effusion; but in purulent effusions—and, according to Fräntzel, in some tubercular pleurisies—the pain is apt to continue. Fräntzel states—"Tubercular and purulent exudations are distinguished from the sero-fibrinous by the longer duration and the greater intensity of the pain, two circumstances which afford a reliable basis for the diagnosis of such cases."[1] The greater severity and duration of the pain in cases of empyema are doubtless due to the fact that the pleural and intercostal nerves are apt to be more seriously implicated by the inflammatory process than in ordinary simple (sero-fibrinous) inflammations. It is in consequence of the same fact that bulging of and fluctuation in the intercostal spaces (conditions which depend upon paralysis of the intercostal muscles) are more frequently associated with purulent than simple (sero-fibrinous) effusions.

The character of the breath sounds and of the cough.—According to some observers, the tubercular character of the respiratory sounds is more pronounced, as also are the amphoric sounds at the apex, when the effusion is purulent, in consequence, it is supposed, of the more intense and prolonged compression to which the lung is subjected around the larger bronchi. At the debate of the Medico-Chirurgical Society of Edinburgh on empyema, Drs. Affleck and James stated that the cough is apt to be more ringing and higher pitched in empyema than in simple (sero-fibrinous) effusions. It is probable, I think, that this ringing character of the cough is due to the fact that in some cases of empyema the inflammatory process involves the recurrent laryngeal nerve. If this supposition be correct, left-sided empyemata are more likely to be attended with this character of the cough, than purulent collections on the opposite side. I may perhaps here refer to the fact that in large effusions, of whatever kind, the character of the voice may be altered. Dr. Stephen Smith Burt attaches great importance to this sign. In speaking of the symptoms characteristic of pleuritic effusion he says:—"But, notwithstanding the paucity of symptomatic indications, there is one result of an effusion when large that seldom fails to arouse my suspicions, and this is the peculiarity of the voice. It always reminds me of the somewhat interrupted manner in which the tones issue from the mouth of a bather while deep in the water."[1]

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[1] Ziemssen's *Cyclopædia of Medicine*, vol. iv., page 632.

To sum up, the diagnostic puncture should be practised in all cases in which the physician has any reason to suspect that a pleuritic effusion is purulent, and more especially in the following circumstances:—

1. In cases in which the associated conditions, previous state of health, or constitutional tendencies of the patient render it likely that pus will be formed, rather than simple (sero-fibrinous) fluid.
2. In cases of pleurisy with effusion in children.
3. When the symptoms and physical signs, which have already been enumerated as suggestive of empyema, are present.
4. In cases of acute, apparently simple (sero-fibrinous) effusion, in which natural absorption does not take place.
5. In cases of chronic pleurisy with effusion (see page 45).

The operative treatment of empyema.—In uncomplicated cases of empyema the first object of treatment is, as has been already pointed out, to thoroughly evacuate the pus as soon as it is discovered. But in selecting the method which it is advisable to employ in an individual case (viz.—(1.) aspiration; (2.) syphon exhaustion; (3.) incision, and the insertion of a drainage tube or tubes; (4.) free incision, without a drainage tube; (5.) incision and resection of a portion of the chest wall) a variety of circumstances have to be taken into account. The more important are as follows:—

1. *The age of the patient.*—In children, aspiration, repeated as frequently as may be required, is often successful, more especially in these cases in which purulent collections within the

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[1] *The New York Medical Journal*, April 23, 1887.

pleura are often limited and localised. But in adults empyemata are very rarely indeed curable by simple aspiration ; for in those cases more especially in which the chest walls are rigid and the lung adherent, it is impossible to empty the pleural cavity by means of aspiration, and free evacuation is, as has been previously pointed out, essential for success.

2. *The duration of the case and the condition of the lung, whether it is adherent or not.*—In recent cases, in which there is no reason to suppose that the lung is adherent, simple aspiration, repeated as often as may be required, and withdrawal of the pus by syphon action, are usually satisfactory and successful methods of treatment in children. They may also be tried, but are seldom successful (curative), in later life. An exception to this statement occurs in those cases in which the pus contains much solid (flaky, fibrinous, coagulated, or curdy) material. In such conditions simple aspiration is often ineffectual, and drainage by the single tube syphon method may not be satisfactorily carried out. For such cases Dr. Robertson claims that his method of double drainage by irrigation (which will be presently referred to in more detail) is specially applicable. In adults, incision and free drainage are generally necessary ; but simple aspiration or continuous syphon drainage are sometimes useful as preliminary measures, inasmuch as they diminish the size of the abscess cavity, and favour a certain amount of expansion of the lung taking place, before air enters and the atmospheric pressure is allowed to bear upon the interior of the pleural sac (*i.e.*, upon the exterior of the compressed lung). Hilton Fagge speaks highly of the syphon method in children. He says—" In children I have sometimes obtained admirable results by making an aperture just large enough to allow one end of a long elastic tube, of which the other end is carried beneath the surface of carbolised liquid in a jar placed beneath the bed. The elastic skin of the child grasps the tube firmly, and does not ulcerate. The negative presence of the column of liquid acting hydrostatically seems gradually to raise the compressed lung. Within

a surprisingly short time the flow of pus may cease, and a permanent cure may be obtained." [1]

My friend Dr. Macdougall of Carlisle tells me that he is in the habit of stitching the edges of the skin round the drainage tube, both in cases in which the continuous syphon drainage is employed and in cases in which a free incision into the pleural cavity and the introduction of a drainage tube have been practised.

When there is reason to suppose that the empyema contains much solid material, or when it has existed some time before the case comes under observation, the method of treatment which it is advisable to adopt must be for the most part determined by (1.) the likelihood of expansion in the compressed lung, and (2.) the condition of the chest wall, whether it is elastic (yielding) or not.

In children, in whom the highly elastic chest wall collapses under the external atmospheric pressure with great facility, repeated aspiration or the syphon method may be tried; but when the lung is firmly and extensively tied down by adhesions, or when the pus contains many solid coagula, free incision and drainage is, even in children, the most satisfactory method.

In adults, in whom the chest wall does not readily collapse, the method of treatment must for the most part be guided by the condition of the compressed lung. When there is reason to expect that the pus is thin, that the lung will expand readily, or that the abscess cavity will be filled up (either by collapse of the chest wall, ascent of the diaphragm, or enlargement of the opposite (sound) lung), the syphon method may be tried, but free incision and drainage will in all probability be ultimately required in most cases of this description in order to effect a permanent and satisfactory result.

Since this paper was written, Dr. Robertson of Oldham has published a series of very thoughtful and important papers on the treatment of empyema, in which he describes and advocates a system of double drainage and irrigation.[1] He bases his treatment upon the argument that the suction force which is required should be just sufficient to counteract the normal elasticity of the lung in ordinary breathing (in other words, to prevent its collapse), but that anything beyond this is injurious. "Under," he says, "the influence of a continuous expanding force, congestion and œdema of the tissues, rendering expansion impossible, and producing effusion into the cavity, would appear to be inevitable" (page 268). He points out that it is difficult or impossible to remove solid or semi-solid coagula by continuous syphon action, and the desired end is only attained after weeks of treatment, while his system of irrigation safely and satisfactorily removes them in the course of a few minutes.

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[1] *Principles and Practice of Medicine*, 1886, vol. i., page 928.

For a description of the apparatus required, and the details of the method of treatment, the reader is referred to the original papers. The practical advantages which Dr. Robertson claims for the method are as follows:—

"We are now," he says, "in a position to form some estimate of the practical advantages this method of treatment offers as regards the restoration of the lung, irrigation and drainage, and asepsis and antisepsis.

"*The restoration of the lung.*—Collapse of the lung is prevented not only at the time of the operation, supposing it to be then capable of collapse, but also during the whole period of treatment. Such portions of the pulmonary tissue as are not involved in the empyema remain in their normal condition, and perform their function by the normal mechanism. The compressed tissues are placed under the most favourable conditions for the restoration of their expansibility, and so far as any portion of them becomes capable of expansion, it is expanded and restored to functional activity. From the evidence of the respiratory oscillation, and from the information derived from drainage and irrigation, the surgeon is enabled to form a fairly accurate conception of the condition of the lung, whether solid, or adherent, or compressed; to follow the progress of re-expansion, and to know when the empyematous cavity has become obliterated by expanded lung tissue.

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[1] *The Medical Chronicle*, vol. vii., p. 473, and vol. viii., pp. 107, 201, and 265.

" *Drainage and irrigation.*—The drainage tube is a syphon, the action of which is rendered continuous by its outer extremity dipping into fluid. For the purpose of drainage, two tubes within the cavity are available, one of which reaches the flow of the cavity, and being flexible, adapts itself to the size of the diaphragm. Hence it will be seen that the appliance is calculated to remove the fluid contents absolutely at all stages of treatment, and these, in place of being deposited on the surface of the body, are removed without coming in contact with it, thereby contributing to the patient's cleanliness and comfort, and abolishing the need for removal of dressings, thus saving the patient from risk and economising the time of the surgeon. The only accident, apart from obstruction of the tube, that interferes with syphon action, is the frequent or continuous entrance of air into the cavity through the thoracic wounds. This is prevented by a special dressing, which, though not of itself valvular, enables the tissues of the wounds to preserve such close contact with the tubes as to effectively exclude air. The dressing is permanent; it does not require removal, as, when properly applied, the wounds do not ulcerate, granulation tissue does not project from the edges, and they give rise to no external secretion. Should circumstances necessitate its removal, it is quite exceptional for air to enter if the tubes are kept from moving in the wounds, and even if it should enter in quantity to arrest syphon action, it is easily expelled by irrigation. Where the contents of an empyema are wholly liquid, continuous syphon drainage by means of a single tube would fulfil all the purposes of treatment. In the great majority of cases solid material, in varying quantity and form, is present, for the withdrawal of which this kind of drainage is not adapted. It is for this purpose that irrigation is employed. Our aim is to remove all the contents of the empyema in this way, and at the earliest possible time after it is opened, substituting in their place aseptic water. In the practice of this method no point has been more impressed upon my mind than the value of irrigation in securing free and uninterrupted drainage. In almost every case the advantage of it was obvious, or the neglect to employ it has to be regretted. The solid matters are stirred up by the fluid injected, and while thus suspended are easily removed by the drainage tube when the drainage force is somewhat increased. It is of the greatest importance, as reference to the cases will show, that the contents should, as far as practicable, be removed at the time of incision. This might be done more thoroughly if the current of the inflow were directed to different parts of the cavity. Of the solid material that remains after the primary irrigation, at least four-fifths are removed by subsequent irrigation, so that only a very small portion of the contents escape by simple drainage. It is obvious, therefore, that the risks of obstruction occurring in the absence of the surgeon are greatly diminished." He then goes on to describe the safety of this plan of irrigation as compared with the ordinary method; and, finally, refers to the prevention, detection, and removal of obstruction during the continuance of simple drainage, and to the advantages which the method affords of maintaining asepsis, and of correcting any septic action which may occur during the progress of the case.[1]

In the *British Medical Journal* of March 9, it is stated that Dr. William Williams, Physician to the Royal Southern Hospital, Liverpool, has obtained very satisfactory results in cases of empyema from the use of a tube with a valvular opening. In treating cases of empyema, he makes a single opening into the chest, and introduces a tube with a simple valve, which allows fluid to pass out of the chest, but prevents air passing in. The tube is retained in position by an ingeniously devised shield, and the granulations that spring up soon make the tube fit air-tight. During convalescence the patient can go about with the tube discharging into a bottle, carried in the waistcoat pocket.

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[1] *The Medical Chronicle*, vol. viii., page 276.

Another method which has been recently employed at the North-Eastern Hospital for Sick Children is resection of a rib and the injection of iodoform emulsion into the cavity of the empyema. Mr. Blake, in reporting the details of six cases which were treated in this manner, under the care of the medical staff of the above named hospital, states "that they were not selected cases. All were treated in precisely the same manner, viz., a portion of rib was excised, the fluid pus allowed to run out, the flaky semi-organised lymph removed with a sharp spoon, and finally 4 ounces of iodoform emulsion injected into the pleural cavity, 3 ounces of which were allowed to run out. That the iodoform emulsion materially hastened the healing process, there can," he states, "be little doubt, for in all cases except one the drainage tube was left out on the ninth day (on the twelfth in the exceptional case), the wound healing —that is, the communication between the pleural cavity and the external air being shut off—from the twelfth to the sixteenth day." [1]

When the lung is firmly and extensively adherent, when the chest wall is rigid, and when the abscess cavity is so large that it cannot be filled up except by the slow and dangerous process of granulation, resection of the ribs is necessitated. The risk which the patient runs from the operation (removal of a large portion of the chest wall) is in many cases less than the dangers (exhaustion, waxy disease, pyæmia, &c.) with which the slow process of filling up by granulation tissue is attended.

When the lung is completely collapsed and incapable of expansion, Estlander's operation is, in the opinion of most authorities, contra-indicated.

3. *The character of the pus.*—In those rare cases in which the pus is septic when the cavity is first opened, and the much more common condition in which an empyema which

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[1] *The Lancet*, February 16, 1889, page 236.

has been opened subsequently becomes septic, washing out the cavity with pure (boiled or distilled) water or a weak solution of boracic acid is advisable. The fluid should not be forcibly injected, but allowed to flow into the cavity slowly under a gentle gravitation force. As has been mentioned above, Dr. Robertson's plan of irrigation (with two tubes in the pleural cavity) seems free from the risks which undoubtedly attend the too forcible injection of fluid into the cavity of the pleura through a single opening.

4. *The condition of the lung as regards previous disease.*—When a pyo-thorax or a pyo-pneumothorax has resulted from or is associated with phthisis, the results of active interference are by no means so favourable as in cases of ordinary (uncomplicated) empyema, and most authorities advise that the abscess cavity should not be opened unless the special circumstances of the case seem to demand it. According to this opinion, the fact that there is a purulent collection within the thorax does not necessarily (in such cases) show that some means of artificial evacuation should be at once employed for its removal. The question is a difficult one. For my own part, I believe that artificial evacuation in some form or another (the exact nature of the method which it is advisable to employ depending of course upon the individual circumstances of each case) might more frequently be employed with advantage in cases of this description (empyema complicated with phthisis) than is recommended by most writers on the subject. In cases of pyo-pneumothorax, the operation should, I think, be deferred, unless the special circumstances of the case seem to require it.

5. *The general condition of the patient.*—It is unnecessary to enter into details with regard to this point; it is obvious that in many cases the general condition of the patient and the nature of the complications and associated lesions which are present must materially influence the decision as to the particular operation which should be carried out.

To sum up, in recent cases in which the lung is not adherent aspiration is often quite successful in the child; but it generally fails in the adult, possibly in some cases because it is not repeated sufficiently often or at sufficiently short intervals.

In the child continuous syphon drainage is often a most successful plan of treatment.

In adults, in cases of empyema of recent origin, aspiration may at first be tried, but if the pus continues to reaccumulate after the operation has been repeated two or three times at short intervals, some more radical method of evacuation must be had recourse to.

A free incision and the insertion of a drainage tube of sufficient size to ensure the complete and continued evacuation of the pus, with the most rigid antiseptic precautions, is the method of treatment which I have been in the habit of recommending under such circumstances, and in my opinion it is the plan of treatment which in the majority of cases will in all probability continue to give the best results.

I have had no personal experience of Dr. Robertson's method of double drainage and irrigation, nor of the treatment by resection of rib and injection of iodoform emulsion, which have been previously referred to. The exact value of these methods of treatment will have to be determined by future experience. So far as I am able to form an opinion, they are likely to be chiefly useful in those acute cases in which flocculi are abundant, and in chronic cases with thickened pleura.

Evacuation by means of a free incision is, however, attended with the disadvantage that it necessarily allows of the entrance of air into the pleural cavity. The atmospheric pressure on the inside of the compressed lung—an active force which, so long as the pressure within the pleural cavity is negative, is continually tending to produce expansion of the compressed lung—is consequently equalised, and expansion of the lung is, theoretically at all events, prevented. As a matter of fact, however, the entrance of air into the sac of the pleura does not seem to interfere so much with expansion, in cases in which the lung is unadherent, as we might theoretically suppose. This disadvantage is remedied, as Dr. Robertson has pointed out, by making the incision and drainage valvular,—in other words, by preventing the entrance of air, while a free exit is allowed for the pus contained in the pleural cavity. Nevertheless the entrance of air must be looked upon as a disadvantage, both because it interferes to some extent with the expansion of the lung, and because, notwithstanding strict antiseptic precautions, septic changes will every now and again occur in cases which are treated in this manner. Theoretically, continuous drainage by syphon action (the suction force being, according to Dr. Robertson, only sufficient to prevent collapse of the lung) seems to present great advantages; but as a matter of fact this plan of treatment is much more difficult to work satisfactorily, in adults at all events, than might be supposed. In order that the syphon action may be exerted, it is essential, of course, that the tube should so accurately fit the opening in the chest wall that no air is enabled to enter the chest from without as the fluid is withdrawn.

A very satisfactory dressing for attaining this result seems to be that recommended by Dr. Robertson.

At a recent meeting of the Medico-Chirurgical Society of Edinburgh, Dr. John Duncan explained a method of continuous syphon drainage, and which he has recently practised, and exhibited cases in which it seems to have been attended with good results.

In children, when the pus contains many coagula, or when the empyema is of long duration and the lung compressed and firmly bound down by adhesions, aspiration or continuous syphon drainage are sometimes successful, but free incision and drainage are usually required. For cases of this description Dr. Robertson's method of double drainage and irrigation seems particularly well suited.

In adults, where the lung is adherent and the abscess cavity is too large to be filled up by the ascent of the diaphragm and the limited amount of collapse which is alone possible when the chest wall is very rigid, resection of portions of the ribs will probably be required. Before, however, this somewhat serious operation is decided upon—for if it is to be successful a very considerable proportion of the chest wall will probably have to be removed—the method of free incision and drainage (without resection of the ribs) should be diligently tried. It is only in those cases in which the latter plan is obviously inadequate to effect a cure that resection of a large portion of the chest wall is in my opinion justifiable; and, as has been mentioned above, when the lung is completely collapsed, many authorities think that the operation is contra-indicated.

The expansion of the lung may in some cases be materially facilitated by lung gymnastics,—breathing compressed air, coughing, making forcible expiration with the mouth and nostrils closed, &c. In those cases in which the lung is so permanently and extensively adherent that no expansion can be looked for, compression of the chest wall by means of strapping helps to produce contraction, and may therefore be desirable.

From the foregoing discussion, it will be apparent that one of the most important factors in determining the particular method of treatment which it is advisable to adopt in any individual case of empyema, is the fact whether the lung is compressed and adherent, or not.

In some cases the point can only be decided by means of experiment, *i.e.*, drawing off some of the fluid by means of the aspirator or syphon, and observing whether the lung is freely expansile or not. One of the advantages which Dr. Robertson claims for his method is the accuracy with which it is possible to determine the condition of the lung and the effect which the syphon drainage is producing upon the cavity of the empyema and upon the lung (*i.e.*, whether the lung is expanding or not).

As a matter of practical experience we know that the lung is more apt to be bound down by adhesions in cases of empyema than in simple (sero-fibrinous) pleurisies.

When, therefore, the effusion is purulent, when it is present in sufficient quantity to exert positive pressure upon the lung (the symptoms and typical signs of which have been described on page 25, and when more especially the condition has lasted for any length of time, we may reasonably expect that the lung is more or less adherent.

In those cases in which the chest is full of pus and the empyema of old standing, the compression of the lung may be quite complete, and the adhesions so dense that it is absolutely incapable of any expansion.

Localised adhesions may of course interfere with the compression of the lung in such cases, just as in ordinary simple (sero-fibrinous) pleurisy. It is difficult, and impossible in many instances, to determine the presence of such (localised) adhesions before puncturing or opening the chest. The auscultatory phenomena and the history of a previous attack of pleurisy are the points on which reliance is to be chiefly placed.

In cases in which there is reason to suspect that the lung is extensively and firmly adherent, aspiration must for the reasons previously advanced be practised with great caution; the fluid must be very slowly and gradually withdrawn, and the operation at once suspended if constrictive pain, cough, dyspnœa, &c. arise. In aspirating under such circumstances (*i.e.*, in the adult, with the object of determining whether the lung is adherent or not), the physician must of course remember that even when the lung is unable to expand, a certain amount of fluid can be usually withdrawn without any alarming symptoms being developed, — the diaphragm ascending, the chest wall collapsing to some extent, and the opposite lung expanding somewhat, as the pus is withdrawn. Indeed, as we have already seen, it is with the object of producing these results (ascent of the diaphragm and collapse of the chest wall), and of producing expansion of those portions of the lung which are still capable of expanding, that aspiration and continuous syphon drainage are chiefly useful as preliminary methods of operative procedure in the adult.

The effects (both general and local) which follow this preliminary aspiration must be carefully observed in the case of empyemata, as in ordinary simple exudations.

If, after aspiration, the pus rapidly accumulates, or if the temperature rises, or if a rigor or any other marked constitutional disturbance ensues, the aspiration should be repeated, but the more radical procedure of evacuating the pus by free incision, and the introduction of a drainage tube under stringent antiseptic precautions, should at once be resorted to.

Details of the operation: size of trocar.—In aspirating cases of empyema, the trocar should be somewhat larger than that employed in ordinary simple (sero-fibrinous) effusions.

The point of puncture must be regulated by the special circumstances of each case. In children, where the collection of pus is localised, the trocar should be inserted over the centre of the effusion. When the purulent collection is more copious, and when aspiration is employed with the object of withdrawing the whole or as much as possible of the pus, the point of puncture must not be too high, but care must at the same time be taken that it is not too low, lest the diaphragm be injured, or lest, as the diaphragm ascends, the free flow of pus through the cannula be prevented. The sixth, seventh, or eighth interspace on the left, and the fifth, sixth, or seventh on the right side, in the posterior axillary line, are in most instances the best positions for the puncture.

The same preliminary precautions (as to percussion, auscultation, &c.) which are advisable in paracentesis for simple (sero-fibrinous) effusions (see page 39) must of course be adopted.

The same circumstances must be taken into account when it is proposed to make an opening into the chest and insert a drainage tube, viz., to make the incision as low as possible in order to drain the abscess cavity from its most dependent point, but at the same time to avoid the risk of wounding the diaphragm, and not to insert a drainage tube so low that it is likely to become blocked by the ascent of the diaphragm after the cavity is evacuated.

In old standing cases of empyemata, the diaphragm is often considerably depressed, and if, after the cavity is evacuated, the lung does not expand so fully as is expected, the ascent of the diaphragm may be proportionately greater than was anticipated. It is consequently necessary in dealing with chronic cases to make the incision at a somewhat higher point than might at first sight appear desirable.

A preliminary aspiration before incising the thorax in cases of empyema is advantageous, inasmuch as it allows to some extent of the ascent of the diaphragm, and hence affords some (though it may not be very reliable) information as to the limit of the incision inferiorly.

In the normal condition, the uppermost part of the diaphragm may, according to Donaldson, " be as high as the fifth interspace on the left, and the fourth on the right side." But in most cases of empyema, more especially when the amount of pus is at all considerable in amount and the case of long duration, the uppermost limit of the diaphragm is considerably lower. The seventh or eighth intercostal space on the left, and the sixth or seventh on the right, in the mid or posterior axillary line, will in most cases be found to be the most suitable position for incision and drainage.

The incision should be made as near the upper border of the inferior rib as possible, so as to avoid the risk of wounding the intercostal artery.

In those cases in which the intercostal space is narrow, or in which it seems likely that approximation of the ribs will take place to such a degree as to compress the drainage tube and to interfere with the free outlet of the pus, resection of a portion of one or more ribs is advisable. Some surgeons, indeed, recommend this procedure in all cases in which the drainage has to be maintained for any length of time.

In most cases resection of a portion of the rib seems to be unnecessary. In cases of recent empyema Douglas Powell recommends that, "after removing the intra-thoracic pressure by aspiration or syphon, in a day or two, to incise the chest and completely evacuate the pus under antiseptic precautions, to insert a drainage tube for a few days only, and then to allow the wound to heal and await results, trusting nature will secrete a fibrino-serous fluid, which will be absorbed." [1]

In those cases in which a purulent collection has been present for any length of time, the point of natural evacuation (fifth interspace near the sternum) should be carefully examined. When the abscess is pointing at this spot, some authorities recommend that it should be selected as the place of incision and drainage. Personally, I am not convinced of the soundness of this advice, for the free drainage is with difficulty obtained by an opening in this situation. My own view is, that in such cases an incision in the usual situation (seventh or eighth interspace in the mid or posterior axillary line) would be preferable; and that even should the special requirements of any individual case seem to make an incision at the place of natural evacuation advisable, a second incision at a more dependent point in the lateral aspect of the chest would probably be also advantageous.

In most chronic cases, one opening, unless Robertson's method is employed, is all that is required, but when one opening is insufficient to secure satisfactory drainage, a second (the drainage tube being passed through the cavity of the pleura between the two openings) may be required. Donaldson states as the result of his experience that in chronic cases especially, the two openings, drainage or incision without tubes (pleurotomy) has finally to be employed.

In cases of septic empyemata, both primary and secondary, and in some aseptic cases in which the drainage is unsatisfactory or interfered with by the presence of large flocculent coagula, the cavity should be washed out with tepid, boiled, or distilled water. Antiseptic solutions are better avoided unless the decomposition going on in the abscess cavity necessitates their use. As previously pointed out, the fluid should be allowed to slowly gravitate into the pleural cavity under a very moderate hydrostatic pressure. Forcible injections are dangerous, and should never be used. In the great majority of aseptic cases of empyema, in which the method of incision and the insertion of a single drainage tube into the cavity is adopted, injections are not required, and in fact are better avoided.

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[1] *Diseases of the Lung and Pleuræ*, p. 534.

The danger of washing out the pleura by injecting fluids into it has been insisted upon by Dr. Basil.[1] He concludes that in the adult the operation is always a dangerous one ; and argues that the operation should only be undertaken with a distinct object in view, and never as a mere matter of routine for the purpose of simply cleansing the cavity.

The advantages which Dr. Robertson claims for his plan of treatment, and the fact that by it irrigation may be freely and safely practised, have been previously referred to.

Should the ordinary method of drainage be insufficient, Fräntzel recommends that a long, soft tube (Nélaton's catheter) should be passed to the bottom of the abscess cavity, and exhaustions should then be practised with a moderate aspirating force. By this means it is possible, he states, to withdraw pus from the bottom or recesses of the cavity when the ordinary washing-out method through a catheter, *à double courant*, fails to evacuate it.[2]

In those cases in which simple aspiration is practised, local anæsthesia is alone required, but when more serious surgical interference (free incision, incision with resection of a portion of a rib, Œstlander's operation, &c.) general anæsthesia is necessary.

When a drainage tube is inserted into the chest, care must be taken that it is so secured (either by an attached rim, sutures, &c.) that all risk of its falling into the pleural cavity is prevented.

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[1] *Medical Chronicle*, August 1887.

[2] Ziemssen's *Cyclopædia of Medicine*, vol. iv., page 729.

For further information as to the surgical details connected with the different forms of operative procedure (incision and drainage with a single or double tube, free incision without drainage, resection of the ribs, &c.) and the management and treatment of the case after operation (mode of dressing, &c.) the reader is referred to surgical text-books. One point only I would emphasise in the strongest possible manner, and that is, the absolute necessity of the most rigid antiseptic precautions, from the moment when surgical interference is first commenced, throughout the whole course of the case, until the external wound is soundly healed and firmly cicatrised.

An admirable summary of the advantages and disadvantages of some of these different forms of surgical procedure will be found in the " International Medical Journal " for July 1888, page 78.

General and medicinal treatment of empyema.—It is of the first importance to remember that in treating cases of empyema, and indeed all affections requiring surgical interference, that the attention of the practitioner should not be allowed to concentrate itself too exclusively upon the surgical aspects of the case. The hygienic, dietetic, and medicinal treatment are all essential. Many of the remedies and general measures which have been recommended for the treatment of the different forms of pleurisy (acute and chronic) may be employed with advantage in cases of empyema. Quinine and the tincture of the perchloride of iron are specially useful in most cases. After the lengthened consideration which has been previously given to this part of the subject, it is unnecessary to again enter into details.

In treating cases of empyema, it is, if possible, even more important than in ordinary simple (sero-fibrinous) pleurisies, to see that the patient is placed in an airy, well ventilated, and aseptic apartment, and that all his surroundings are kept scrupulously clean and sweet.

PART III.

THE PREVENTIVE TREATMENT OF PLEURISY AND EMPYEMA.

In pleurisy, as in all other diseases, the fundamental principles on which the preventive treatment is to be based are—*firstly*, to remove the predisposing cause, whatever it may be, which makes the patient more liable to be attacked by the disease than the average healthy person; and *secondly*, to protect the patient (who, in consequence of some constitutional or local defect, is predisposed to the disease) from the exciting cause or causes of the condition.

Now, in many cases it is obviously impossible to prevent the occurrence of pleurisy: in the course of phthisis, for example, pleuritic inflammations must necessarily from time to time occur, as a result of the extension of the lesion to the surface of the lung and the involvement of the pleural tissues. So, too, in septic conditions, the only certain means of preventing the occurrence of pleurisy is to remove the source of the sepsis, or, if a septic focus is already established in some part of the body, to render it aseptic as speedily as possible, avoiding at the same time all the conditions which may act as excitors of pleuritic irritation and inflammation, and which may render the pleura liable to be implicated in the septic process.

The same principles of prevention hold good in Bright's disease, rheumatism, and the other constitutional conditions in which we know, as the result of experience, that pleuritic inflammations are prone to occur.

It is generally believed that exposure to cold (more especially moist cold—cold and wet—and draughts directly playing upon the thorax) is a frequent, probably *the* most common direct and exciting, cause of acute pleurisy in healthy or apparently healthy individuals, and still more so in those who are debilitated or diseased. With this opinion I entirely agree.

Dr. Ransom, for whose opinion I entertain the greatest respect and esteem, holds a different view. He does not admit that exposure to cold is the cause of acute pleurisy, or any other such inflammation, in an average healthy person.

In considering the probable effect of cold as a cause of disease, it is, I believe, important to remember the somewhat artificial existence in which the mass of the population lives, and the fact that the great majority of our town population at all events—and more especially those whose occupation necessitates a sedentary mode of life, and who live in hot, close rooms—are unaccustomed to expose themselves to every change and vicissitude of the weather. These conditions are obvious causes of diminished or weakened resisting power. In consequence of this diminished resisting power, the nerve tone is lowered, and the perfect working of the self-adjusting vaso-motor and temperature mechanisms, and the proper production of those reflex alterations which occur in the absolutely healthy individual, when a portion of the surface or the whole body is exposed to sudden variations in temperature and altered temperature conditions, are interfered with.

The fact that the great majority of individuals may expose themselves to cold and wet, draughts, &c., with impunity, and that every individual who is attacked with pleurisy or rheumatism (apparently as the result of exposure to cold, wet, draughts, &c.) has on previous occasions been over and over again exposed to these same conditions without having been injuriously affected, does not of course show that exposure to cold is not (or was not in the specific instance referred to) the cause of the disease.

In the upper and middle classes, the persons who can altogether disregard the vicissitudes of the weather and who can expose themselves to draughts with impunity, constitute, it may be safely asserted, the minority. Persons whose vaso-motor tone is low, those who feel small variations of temperature, those who bear both heat and cold badly, are, I believe, especially liable to suffer from rheumatism, pleurisy, and other inflammatory affections after exposure to cold, wet, draughts, &c.

That exposure to cold does produce localised facial (Bell's) paralysis is, I suppose, almost universally believed. It is, however, only fair to state that no less an authority than Professor Charcot thinks the importance of cold as the cause of facial paralysis has been very much overrated. Professor Charcot agrees with Neumann in thinking that facial paralysis is often the result of an hereditary tendency to nerve disease; and he further points out that it is by no means very uncommon to meet with several instances of Bell's paralysis in the same family.

I know from my own personal experience that localised rheumatism (stiff neck, lumbago, &c.) may be produced by exposure, and I am convinced that general articular rheumatism is frequently produced by (or, to speak with the greatest accuracy, directly follows upon) exposure to cold and wet. Further, many good authorities mention specific instances in which pleuritic inflammation has been produced by a draught playing on the thorax. Thus Hilton Fagge states—"I quite agree with Fräntzel, that the clinical evidence in proof of the direct dependence of pleurisy upon cold is of the most striking character, and such as cannot possibly be explained away. He cites, for example, cases of persons who have been attacked after having exposed one side of the body to a draught in changing their clothes while heated, or after having got one side wet through in a driving rain. Other cases have immediately resulted from sitting near an open window or by a badly fitting door, especially during convalesence from some acute illness, or (it is said) after a course of mercurial treatment."[1]

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[1] *Principles and Practice of Medicine*, vol. i. p. 933.

Whether the exposure to cold (draughts, wet, &c.) is the sole cause of the attack in such cases is of course a different matter. But the point that I would strongly emphasise from my own personal experience is this, that certain persons at certain times are liable to be attacked by rheumatism (both localised and general), and, I believe, by pleurisy and other similar (inflammatory) affections, if they expose themselves to cold, wet, draughts, &c. That in such conditions of the system the individual may be perfectly comfortable so long as he remains indoors, or does not expose himself, and that he may immediately become conscious of rheumatic pain (muscular or articular) as soon as he does expose himself, and that in some instances the muscular or articular pains are immediately felt in the particular parts (localities) which are exposed. I feel convinced, therefore, that exposure to cold is frequently the exciting cause of the rheumatic attack (and probably also, I believe, of pleuritic and other inflammations); and that in many instances a rheumatic attack may be warded off or prevented by carefully avoiding the exposure, which is, I believe, in so many instances its direct exciting cause.

The manner in which exposure to cold (wet, draughts, &c.) may produce disease is probably various. In some cases—as, for example, those cases in which a draught or blast of cold air produces localised facial or localised rheumatism (stiff neck, lumbago, &c.) in the part which is directly exposed to it—it seems reasonable to conclude that the action is a local one. In other cases the action is in all probability remote or reflex. It is, I think, not unlikely that, in some cases, the surface alterations which result from exposure to cold produce, reflexly through the nerve system, localised vascular alterations and disturbances of nutrition in the great internal viscera (such as the liver); and that in consequence of the deranged metabolism which is produced in this manner, lactic acid or some other substance is generated, or that some product of tissue metabolism which ought to be excreted is retained in the circulation, and that the poison, as we may term it, which is produced or retained in this manner, is the immediate exciting cause of the rheumatic or inflammatory condition.

Some writers also think that localised inflammations in the internal viscera may result from localised vascular alterations being reflexly produced in the affected parts by the external exposure; but this view seems doubtful, for, as Leber and Gowers have argued in considering the mode of production of the double optic neuritis associated with intracranial tumours, it is extremely doubtful if vaso-motor alterations *per se* can or do produce true inflammatory changes.

But given a tendency to rheumatic or other inflammation (in other words, given the presence in the blood of a poison which is the exciting cause of rheumatism or inflammation), it is not, I think, unreasonable to suppose that the vaso-motor alterations in internal parts (say the pleura), which result from surface alterations in temperature, may add, as it were, the element which is necessary for the production of the local outburst; in other words, the exposure may determine not only that an attack or outburst does occur, but also the locality which is affected by it.

The important practical bearing which those theoretical considerations have in the prevention of rheumatism, pleurisy, and some other inflammatory affections (granting, of course, that they are true), is obvious.

The indications for the prevention of rheumatism, pleurisy, and other affections, which are likely to follow exposure to cold, are, in my opinion, as follows:—

1. To maintain the general health in the highest possible state of efficiency, by careful attention to the diet, hygienic surroundings, exercise, and whole mode of life of the individual, special care being taken that the great depurating organs (liver, intestine, kidney, and skin) are kept in an active and healthy condition.

2. To avoid all conditions which lower the vaso-motor nerve

tone, and which impair the efficiency of the self-adjusting nervous mechanism, by means of which the injurious effects of sudden alterations in temperature (cold, wet, draughts, &c.) are guarded against and prevented.

Although I differ from Dr. Ransom in believing that exposure to cold is often a most powerful factor in the production of disease, I entirely agree with him in thinking much injury results from over-crowding and from the dread of fresh air, which is far too prevalent. Nothing, in my opinion, predisposes more to taking cold than over effeminacy. Persons who are susceptible to cold, and apt to take rheumatism, &c. by exposure, should be encouraged, while avoiding draughts, to live in cool, well-ventilated rooms by night as well as by day, to take plenty of out-door exercise, and to gradually accustom themselves to go out in bad as well as in good weather. A cold bath in the morning is in my opinion an admirable means of strengthening the vaso-motor nerve tone, and is to be strongly recommended, provided that it is tempered with discretion. Few persons, even the most robust and healthy, and especially those who have reached the age of fifty, can take with impunity (without the risk of doing themselves far more harm than good) a perfectly cold bath, both in winter as well as in summer. I feel the very reverse of admiration for those robust but mistaken enthusiasts who break the ice and immerse themselves in water which is hardly above the freezing-point. The great general rule which should be laid down as regards cold bathing is that the water should be sufficiently cold to be invigorating, but not so cold as to produce depression. Unless the vaso-motor reaction is vigorous and a pleasant after-glow is experienced, cold bathing should be forbidden. In the course of time, and as the vaso-motor tone becomes strengthened, the temperature of the water may be gradually lowered. In delicate persons the effect of the bath in each individual case must be carefully noted. Indiscriminate cold bathing should never be prescribed.

3. Such special precautions as may seem necessary in each

individual case must be enjoined. Persons who inherit the rheumatic tendency, still more those who have actually suffered from rheumatism, pleurisy, or any of the other affections which are supposed to be produced by exposure to cold, persons whose vaso-motor nerve tone is feeble, those also who feel extremes of temperature, persons who are debilitated from any cause, and those who are suffering from Bright's disease or any affection in the course of which rheumatism, pleurisy, or any other affection due to cold are apt to occur, must of course be specially careful as regards their clothing, and must take the greatest care not to get wet through or expose themselves to draughts and sudden variations of temperature, as, for instance, passing from a very warm into a cold atmosphere.

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